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REPORT OF THE MALARIA EXPEDITION TO THE GAMBIA

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ISSUED BY THE COMMITTEE

OF THE

LIVERPOOL SCHOOL OF TROPICAL MEDICINE AND MEDICAL PARASITOLOGY

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REPORT

OF THE

MALARIA EXPEDITION TO THE GAMBIA

1902

OF THE

LIVERPOOL SCHOOL OF TROPICAL MEDICINE
AND MEDICAL PARASITOLOGY

BY

J. EVERETT DUTTON, M.B., B.CH., VICT.

AND AN

APPENDIX BY F. V. THEOBALD, M.A.

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REPORT OF THE LIVERPOOL MALARIA EXPEDITION TO THE GAMBIA

I. PRELIMINARY

ERRATA

In acknowledgment, line 11, for 'Lieut. G. C. YOUNG,' read 'Lieut. G. C. TRACY.'

P. 4, l. 23. For 'regular,' read 'irregular;' for 'rarely,' read 'readily;' for 'up,' read 'off.'

P. 9, l. 33. For 'Lieut. YOUNG,' read 'Lieut. TRACY.'

P. 10, l. 19. For 'Mr. BARNOIS,' read 'Mr. BUDGETT.'

P. 10, l. 24. For 'cus cus,' read 'koos-koos.'

P. 10, l. 34. For 'Lieut. YOUNG,' read 'Lieut. TRACY.'

P. 21, last line. For 'ground,' read 'drain.'

P. 26, l. 21. For 'mosquito' read 'mosquitoes.'

P. 33, l. 22. For 'mosquito-room,' read 'anti-mosquito-room.'

P. 34, l. 5. For 'country,' read 'community.'

P. 34, l. 37. Before 'water,' read 'tidal.'

P. 36, l. 36. Professor HERDMAN has recently kindly identified for me the specimens of fish taken from the main drains of Bathurst; two specimens so far occur. They are :—

Hemichromis fasciatus (GILL.)

Chromis maculiceps (BLEEKER)

P. 39, l. 30. For 'great,' read 'greater.'

on it was shown that certain members at least, if not the whole genus *Anopheles*, did not necessarily require such specialized breeding places, for if from any cause they were absent these mosquitoes would breed in any collection of water, just as the genus *Culex* does.

REPORT OF THE LIVERPOOL MALARIA EXPEDITION TO THE GAMBIA

I. PRELIMINARY

DURING the past two years a great deal of energy has been displayed in many parts of the world to put to some practical use the great discovery of the definitive host of the malaria parasite. The knowledge that the mosquito is responsible for the transmission of malaria has immensely increased the possibility of combating this disease by prophylactic measures. The measures which have been recommended by various investigators naturally group themselves under two heads—

1. Destruction of the parasite in its intermediary host, man.
2. The prevention of the transference of the parasite from one host to the other, viz., from man to mosquito, or mosquito to man.

Under the latter group many methods have been advocated, and much literature has accumulated during the last three or four years. The modes of attack have centred round the vulnerable stage in the life cycle of parasites in general, viz., the transference from one host to another; thus in the case of the malaria parasite the points aimed at in this stage are—

1. Destruction of the definitive host, the mosquito.
2. The prevention of infection of the mosquito.
3. The prevention of inoculation of man by the mosquito.

It was hoped in the early stages of the work of investigation on the mosquito cycle of the malaria parasite that it would be a matter of comparatively little difficulty to destroy the parasite in this stage of its history by means of the destruction of the mosquito carrying them, especially as only one genus of the *Culicidae* (*Anopheles*) was implicated. Major Ross, in India, and other investigators had pointed out the broad fact that the genus *Anopheles* required, as a rule, breeding-places of a rather special character for their propagation, very shallow surface pools of sufficient depth to last over a week. By the prevention or treatment of these pools it was thought that the mosquitoes could be done away with. Maps were made marking out the distribution of such breeding places throughout certain districts with this object in view. Later on it was shown that certain members at least, if not the whole genus *Anopheles*, did not necessarily require such specialized breeding places, for if from any cause they were absent these mosquitoes would breed in any collection of water, just as the genus *Culex* does.

Up to 1899 some one hundred and twenty-two definite species of the *Culicidae* were described. Since that time many collections of mosquitoes have been examined from all parts of the world. Mr. F. V. Theobald, at the close of last year, as the result of an exhaustive examination of past works and new material, has remodelled the classification of the *Culicidae*, which he has grouped into some twenty-two genera, and has described some one hundred and thirty-six distinct new species in his *Monograph of the Culicidae of the World*. To this number must be added some one hundred new species which he has not yet described.

As yet only a few of the great number of mosquitoes have been investigated with regard to the important point of whether or no they can act as hosts for the malaria parasite. In fact only a few species of *Culex* have been shown to be incapable of transmitting the disease.

When it was considered that not only malaria but other diseases were conveyed by mosquitoes, for example, filaria can develop in two genera, *Culex* and *Panoplites*, and that yellow fever is certainly carried by one genus, *Stegomyia*, there arose a tendency to look upon all mosquitoes as harmful, and that their judicial destruction, as far as possible, was an object to be aimed at. How far this end can be attained is at present *sub judice*, but we have evidence that certain districts and towns lend themselves readily to this object.

Experiments under this head are at present being carried on in West Africa and in Havana. On a smaller scale similar experiments have been carried out in Hong Kong and Statin Island, New York. Major Ross chose Freetown, Sierra Leone, for the scene for an experiment, to see how far mosquitoes can be diminished in a certain area, one of the most difficult places on the West Coast to tackle. He and Dr. Logan Taylor, who was to direct the work there, arrived on July 2, 1901, and at once commenced the campaign against all varieties of mosquitoes. As yet the experiment is not completed, but a great diminution in the numbers of these insects has already been brought about.

In Havana the work of exterminating mosquitoes, by the destruction of their breeding places, was commenced soon after the discovery that yellow fever could be transmitted by the bites of the common mosquito, *Stegomyia fasciata*. Major and Surgeon W. C. Gorgas, in his January report to the Military Governor, states that out of seventeen thousand houses examined during the month by the 'Stegomyia Brigade,' in four hundred and eleven only were mosquito larvae found; the preceding January, larvae would have been found in all of the houses. Not only have the mosquitoes diminished, but Havana has been for the last four months, October, November, December, January, entirely free from yellow fever. This result is certainly very encouraging when we compare the prevalence of yellow fever there during the same period of the previous year, when the average number of deaths from this disease was 146·49.

II. TOPOGRAPHY AND STATISTICS

St. Mary's Island and Bathurst

St. Mary's Island is a long, low-lying island at the mouth of the River Gambia, extending roughly from north-east to south-west along the south bank of the river. It is about four miles long and half-a-mile across at its widest part. The island is only separated from the mainland by a small creek, which, at the north-west corner, is bridged across. One fairly good road runs the length of the island, from the town of Bathurst at the one end to the Creek Bridge. This road runs along the beach, separated from it for the most part by mounds of sand and scrub. On the south side of the road an extensive mangrove swamp occurs, and in places encroaches on to the road.

The town of Bathurst is situated at the east corner of St. Mary's Island. It occupies an ⊥-shaped area of land, the long arm of which is almost separated from the island by an encroachment of Oyster Creek at the back of the island and the mangrove swamp. There is only a distance of some two hundred yards between the swamp and the beach, so that this area is for the most part cut off from the island, and is surrounded by a broad expanse of water on all sides, to the north and west by the River Gambia, which is here about four miles across, to the south and west by the creek separating St. Mary's Island from the mainland. In this area the land scarcely reaches the height of four feet above sea-level, the greater part of it being situated below the sea-level. Altogether it is scarcely a square mile in extent.

The formation is of light sand and loam on the surface, followed by denser loam which rests upon the water-bearing sand and silt, about eight feet under the surface. This area is well though not too thickly wooded ; some very fine trees occur in the town.

The town of Bathurst is very well laid out. The chief streets are broad and run parallel and at right angles to one another ; in fact there are very few narrow streets, even in the strictly native quarters. The chief houses and factories in the principal street, Wellington, face the mouth of the river. These houses are built of stone for the most part, the volcanic iron stone which occurs in great quantity across the river. These houses are very cool and airy, and the rooms are large ; they were probably built by the French. At the back of each house there is generally an enclosed piece of ground used as a garden.

Unfortunately, in Bathurst, the houses of the Europeans are not segregated from the natives, many of the traders' and officials' houses, particularly, being surrounded by native compounds. Government House, the Colonial Secretary's house,

the Hospital, and the Telegraph Station are slightly better in this respect, but here only a road (Clifton Road) and an open space about one hundred yards across separate them from a bad portion of the native town (Portuguese Town), and on this portion of land a few huts are present.

In the centre of Bathurst there is a fine open space, McCarthy's Square. On one side of this square is a very picturesque building, the Barracks, occupied during the time I was at Bathurst by a West Indian Regiment. The creek separating St. Mary's Island and the mainland commences at the back of the town of Bathurst ; and here it is about half-a-mile to a mile across. The ground in this part of Bathurst is very low-lying, and parts of it are below sea-level. To prevent the encroachment of tidal water a wall two to three feet high has been built. This wall extends for a considerable distance, the remainder being a mud embankment. Within this ⅃-shaped area of St. Mary's Island described above two large swamps occur, namely, Half Die and Box Bar. The former swamp is situated in the smaller arm and is not tidal, owing to the low wall mentioned above. Native compounds occur all along these marshes, which in the wet season are often covered with water. Down the centre of this swamp a wide channel runs and opens into the creek by means of sluice gates.

The other swamp, Box Bar, is situated at the back of the town, in the larger arm of land ; along its centre an open drain runs, which falls in a similar manner by means of sluice gates into the creek. On either side of this swamp the native town extends for some distance, as Portuguese Town on the one hand and New Town on the other. This swamp is larger than the preceding one and is partially covered by rank grass and low scrub. Its surface is much more regular, so that the collections of water are rarely shut up from the central channel ; there appears to be a distinct fall, though slight, from the sides to the centre. Both of these swamps in the dry season only contain tidal water, which oozes through the sluice gates and sand into the central channel. In the wet season they practically act as reservoirs for rain-water. There is, besides, another smaller swamp.

Population of Bathurst.—The European population of Bathurst varies slightly during the year, some of the officials and traders returning home during the wet season. There are some seventy to eighty persons. The native population is estimated at about fifteen thousand ; they include the Joloffs, Mandingoes (Mohammedans), and a small number of Jolahs (Pagans), and a good few Sierra Leone traders. Besides this there is a small fluctuating population of Assyrian traders, estimated at about one hundred. These people trade in small articles among the natives, and live in an extremely filthy condition. A few cases of yellow fever which occurred in Bathurst last year were supposed to have arisen by means of these people.

Drainage of Bathurst.—Provision is made for the carriage of surface water by means of open gutters, which run down the centre of the main streets. These open channels commence at the higher portion of the town as shallow gutters, about

eighteen inches deep. During their course along the streets they are made deeper in order to obtain a good fall until they reach the beach, where some are thirteen feet deep and three feet wide. Similar drains from the side streets enter at right angles into these drains ; the water from them is discharged into the river by means of sluice gates, which are opened at low tide. Altogether there are about half-a-dozen such gates. The construction of the drains varies to a considerable extent. The main drains opening into the river are square, flat-bottomed, built of stone, lined with cement, and are for the most part impervious. Further in the town the channels are built with stone, but some of them are only partially cemented, either the iron-stone blocks on the sides or the bed of the drain being uncemented. These channels allow the ground-water to percolate into them at certain seasons of the year. Still further in the centre of the town the drains become very shallow and are made of bricks, trough-shaped and uncemented.

Many of the streets have no 'made' drains as described above, instead, a centrally situated trench is dug in the ground, which either discharges into the main drain or discharges at the back of the town, directly into the swamp. These trenches vary considerably in depth and width, some of them being four feet from the surface of the ground. In some of the drains the earth dug out to form the trench is built up on either side of it so that the surface of the street falls away from the trench. Similar trenches occur round compounds, squares, and in the grounds of the Europeans. They are for the most part choked with grass, or natives walking across from one side of the street to the other carry with them sand or débris, converting the drain into a series of holes in the centre of the street ; some of them are so choked in this way along their course and at their outlets that it is impossible for the contained water to escape. At the corners of the principal streets these drains are bridged over by low brick arches. In this situation the drain frequently has a stone placed in its course or a cemented catch-pit has been constructed ; here water lodges for a considerable period after the rain has ceased. Later on it will be shown how many of these drains afford considerable breeding-grounds for mosquitoes.

Water Supply.—Rain-water is used for drinking purposes by the Europeans, and also by some of the native traders. It is gathered from the roof and stored in large tanks. Some of these tanks are fitted with good covers, others are not covered properly, so that insects, dirt, etc., contaminating the water, obtain an entrance beneath the cover of the tank. The best tank seen was one in which the only mode of access to the tank was by means of a man-hole at the top, with a heavy, fluted, iron lid, difficult of removal. Some of the native traders also collect rain-water in large iron boilers or tubs. These are for the most part inadequately covered, or not at all. For domestic purposes, water is obtained by the Europeans from wells sunk in their gardens. The native population of Bathurst obtain water solely from wells.

The wells of Bathurst are of two types, namely, deep wells and shallow or tub wells.

The deep wells occur as public wells, built by the Government. In the streets in various parts of the town there are about a dozen altogether. Similar wells are present in some of the European and native traders' compounds. They are on the whole well built of stone and steined with cement for a good distance down. A wall two feet high generally surrounds the well, but unfortunately very few of them are covered in. Of fifty-five private wells examined only thirteen were properly covered ; of the public wells, one only. Thus it is an easy matter for these wells to become foul ; this is generally due to sticks, half-peeled oranges, pawpaw rinds, and other rubbish thrown in by children. The depth of these wells varies from fifteen to twenty feet. The second class of well, the small tub well, occurs chiefly in the native compounds and in the gardens of the Europeans. They are very shallow, a hole being dug about three feet in the ground by a native and a barrel inserted into it, in which water collects. The rim of the tub may be flush with the ground, but it is generally about four to six inches above. Close to these small wells in the native compounds, in many instances scarcely four yards away, occur the cess-pit or midden and the screened-off personal wash-place. It is not difficult to understand how easily polluted these wells become. Many of the natives appreciate this, and on enquiry will tell you that they go to the public wells to get water for drinking purposes.

Climate of Bathurst.—With regard to climate, Bathurst represents a contrast to other parts of the Coast. Its situation on an island surrounded almost on all sides by a broad expanse of water tends to modify the extreme heat and dampness met with in other parts of the Coast. The dry season commences at the end of October and ends at the beginning of May. During these months the harmattan blows from the interior, and great variations between the maximum and minimum temperature may be recorded, a temperature of 100° during the day, while at night it is not unusual to have a temperature of 60°. These months are very trying to the native population, and many cases of bronchitis and pneumonia occur amongst them. During this season practically no rain occurs. The wet season sets in in June and ends in September. In the months before and after this period, that is April and October, some heavy showers may occur. In these months the temperature is much more even. The highest maximum recorded in the shade never reaches 100°, at least has not done so for the past five years ; it is generally about one or two degrees above 90°. The lowest minimum temperature recorded for these four months keeps about 70°. Chart (I) gives a record of the temperature of the maximum and minimum for 1900. For the last five years charts constructed in a similar way show practically the same curves. The rain-fall of Bathurst does not vary much above fifty inches, and this occurs in the four months, June, July, August, September. In October the wet season ends. After October rapid drying takes place. The wet season, owing to the great humidity and absence of any appreciable variation in atmospheric temperature, is exceedingly trying to Europeans.

Food.—Europeans at Bathurst are fortunate with regard to fresh food ; fresh meat can be obtained every day. There is a special slaughter-house for cattle, situated behind the market, which is under the supervision of the Sanitary Board. Fish is brought into the town twice daily, and is of excellent quality. Very good bread can be obtained from the various traders, particularly the French Companies ; the smaller native traders also sell bread in the market. Throughout the dry season English vegetables of all kinds are easily obtainable. Many of the European officials and European traders make a point of growing these vegetables, and I observe that the natives are, in a small way, imitating the Europeans in this respect. Many of them grow onions and tomatoes to sell in the market. Through the energy of the French Company ice can be obtained all the year round.

Disposal of Refuse.—Amongst the Europeans, sand closets are almost universally used, being emptied every day by a staff of night-soil men. With regard to the natives, public latrines are provided by the Government. At times it happens that excretal matters are washed by the tide on to the foreshore. In the compounds of the more wealthy class of natives middens are used ; some of these are of very large size, and are not made impervious to water. In the smaller compounds a tub placed in the ground is used as a privy. Only occasionally earth or lime is mixed with the excretal matter. When full, which takes from one to two years, the tub is discarded and another inserted in a fresh place in the compound. Both the tubs and privies were found to be infested with multitudes of fly maggots. The Jollofs, who constitute about one-third of the population of Bathurst, have no middens or tubs in their compounds ; instead, an earthenware jar is used to retain excreta, the jar being emptied every day, either in the morning or at night, into the river. These people are particularly clean and tidy and take a pride in keeping their compounds in good order. Dry refuse is removed from the various compounds by the Sanitary Board's carts, which go round the town every day ; this refuse is dumped on the borders of Box Bar swamp.

Prevalence of Malaria Fever in Bathurst.—With such a comparatively small and fluctuating white population in Bathurst it is difficult to estimate exactly the prevalence of malarial fever amongst the Europeans. From the medical officers' reports, which the Colonial Surgeon, Dr. R. M. Forde, very kindly allowed me to consult, I was able to obtain the following data for the last three years :—In 1898, out of a total European population of sixty-three, twenty-three persons were admitted into the hospital for various diseases, but principally for malarial fever. There were three deaths for the year, two from haemoglobinuric fever and one from malarial cachexia ; during the year there were four cases of blackwater fever amongst the non-official European residents. In 1899, out of a population of eighty, twenty were admitted during the year into the hospital, chiefly for malarial fever. Of the non-official white population sixty-six were treated during the year ; of these thirty-seven were cases of malarial fever of the remittent type and three were cases of haemoglobinuric fever ;

there was one death from cardiac failure after enteritis. In 1900 there were eleven Europeans in the hospital ; two deaths occurred, one from dysentery, the other was a sailor landed in Bathurst with an abscess in the brain. Of the non-official Europeans sixty-nine were under medical treatment ; of these thirty-five were malarial fevers of the remittent type, with one death ; seven were believed to be yellow fever, with six deaths. It is stated in the reports that the severe cases of fever occur during the latter part of the year, from July onwards, that is, after the wet season has fully set in. In connexion with these figures the Colonial Surgeon points out that a fairly large percentage of Europeans return to England during the wet months. During the past year, 1901, there has been stationed in Bathurst a company of the West Indian Regiment. These men, though drafted from Sierra Leone, had for the most part originally come from Barbadoes and other West Indian Islands where endemic malaria does not exist, thus they were in the same category as the white man entering an endemic malarial district, and were therefore specially suitable to study the liability to infection with malarial fever. Further, no special precautions were taken amongst them to ward off attacks from mosquitoes, nor was quinine administered as a prophylactic. The men arrived in April, and were quartered in the barracks, McCarthy Square. Some of them went away for a short time in the early part of the year on a punitive expedition against some tribes up the river ; altogether there were one hundred and eight men. The following chart shows the percentage of cases amongst

(Chart I)

this force admitted into hospital with malarial fever during each month from April, 1901, to January, 1902, indicated in the chart by the thick line. The fever was for the most part remittent in character, and the diagnosis was to a large extent confirmed by microscopical examination of the blood. The curve does not represent the total number of malarial fever cases occurring amongst the soldiers, as many soldiers suffering from only slight attacks of fever were not ill enough to be admitted into hospital. With this chart is also given the rainfall in inches, and the maximum and minimum temperatures in the shade for the year. It will be seen that the greatest percentage of malarial cases occurred in the months of September, October, and November, and that there was a marked decline from December to January ; in the latter month no cases occurred. During the former months innumerable mosquitoes are present in Bathurst ; the rainy season being fully established during July and August has so raised the level of the ground water that many suitable breeding-places occur along the borders of the swamp and in the drains, etc. Besides the old observations illustrated in this chart of the relation between rainfall and malarial fever, it is also interesting to note that the greatest percentage of malarial fever cases amongst the soldiers also occurred in those months when the variations in atmospheric temperature are least marked, namely, July, August, September, October. The average variations between the maximum and minimum temperatures in the shade in these months

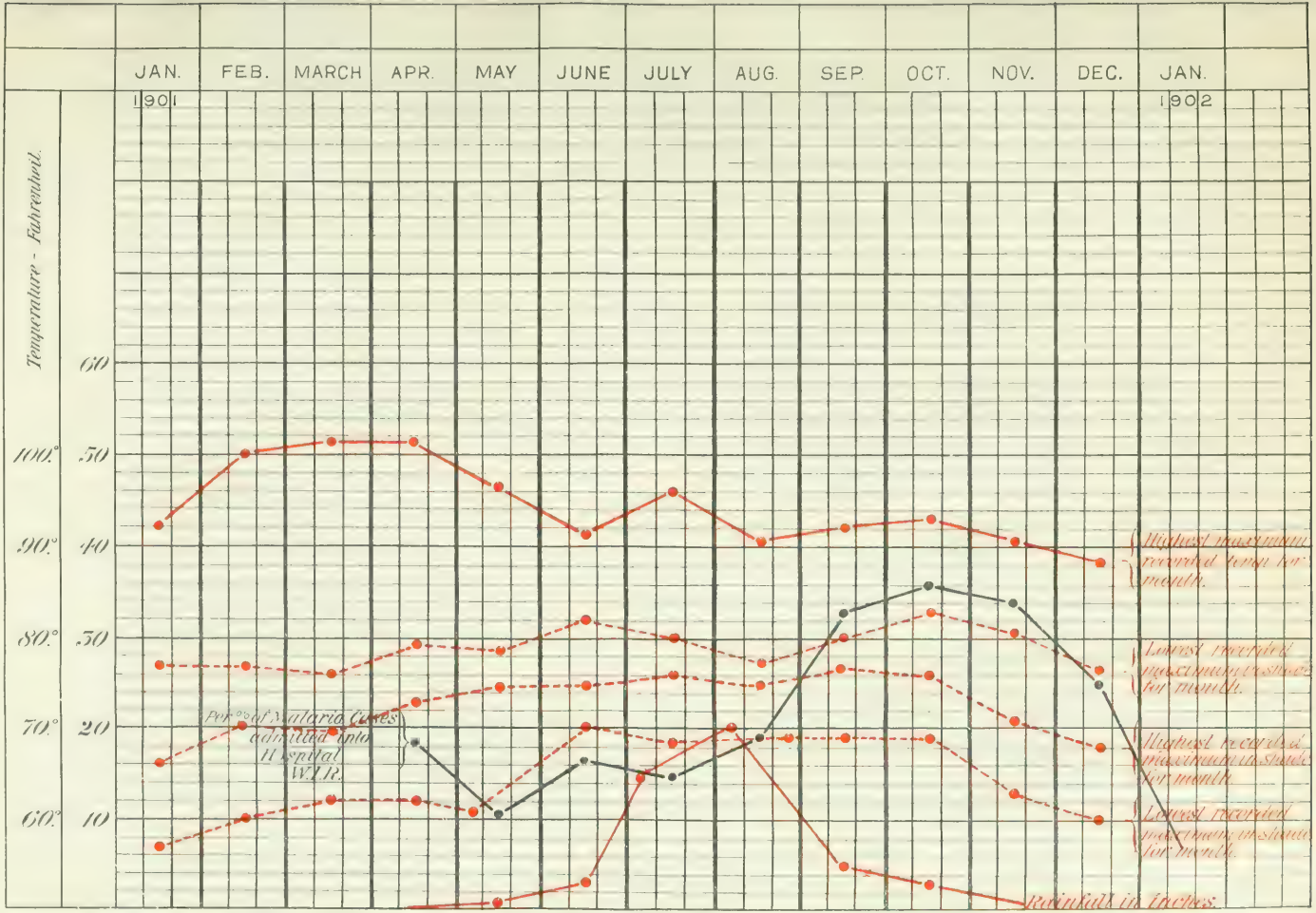


Chart I. Fever cases amongst the West Indian Soldiers stationed at Bathurst with rainfall and temperature curves for year.

being 25°, while in January, February, March, April, and May the variation in temperature is not less than 40° ; it would appear, then, as pointed out by Dr. R. M. Forde in his Medical Report, that the liability to infection occurs soon after the rains are established, lasting up to the end of November.

Cape St. Mary

About seven miles from Bathurst, on the mainland at the mouth of the River Gambia, is a promontory known as Cape St. Mary, or simply the Cape. The road from Bathurst leads directly to it, and is perfectly level until a distance of about three hundred yards from the Cape is reached ; the ground then rises rather suddenly to the summit of the promontory about one hundred feet. Cape St. Mary is the termination of the low cliffs of volcanic and sandstone rock which skirt the sea border to the south of the River Gambia. I had an opportunity of staying there two days in the Government House, which is built on the edge of a cliff facing the sea, and is now used principally as a convalescent station. Besides Government House, a few traders and others have built bungalows here and there along the cliffs. On either side of the road leading to Government House, and extending from right to left, is a large Mandingo town, and at the foot of the hill itself is an extensive swamp in which the natives grow their rice. There is no doubt that the climate at the Cape is very bracing and very beneficial to convalescents after fever. It is extremely unfortunate that Government House is situated so near the native village, in which endemic malaria and other diseases are very prevalent, and also that the rice swamp is so close at hand, breeding millions of mosquitoes, which not only cause much annoyance but are a real danger to the residents in the house. This swamp had not completely dried up on December 27, when I examined it, although there had been no rain for two months previously. Many mosquitoes were still breeding in the puddles ; it would appear that even during the dry season mosquitoes infest the district, and in fact I had no difficulty in obtaining them for examination. The natives collected very many for me from their huts, and these for the most part belonged to the *Anopheles* genus. About a mile away from the Cape, on the Coast, is another promontory jutting out into the sea. This presents an ideal site for a Sanatorium, as the land at the back is high and level for a considerable distance stretching into the interior, and also no native huts appear within a radius of a mile.

I took the opportunity of travelling with Lieutenant Young to see some of the stations up the river. Unfortunately only a short time was at my disposal, so that no detail work could be done. We travelled up river in December, when the dry season was fully established. At McCarthy Island, one hundred and fifty-three miles up, is the most important station ; here there is a Government House and a few traders' factories. The island is very low-lying and swampy ; a rice swamp, at this time dried up, lies by the edge of the river. Close to the principal native

town, and behind the town, half-a-mile away, there is also another large swamp running along the centre of the island, probably the old course of a river. In the large swamps innumerable mosquitoes occurred. Government House is situated close to the native town, surrounded by old stone ruins, which afford suitable hiding-places for mosquitoes in the dry season; there were many mosquitoes about. One European was staying in the Government House when we visited it, and in his room I found, in the middle of the day, innumerable specimens of *A. funestus* and its varieties resting on the walls. A well present in the compound was devoid of *Anopheles* larvae, though larvae of the *Culex* type were present in numbers. These mosquitoes must have either flown from the swamp at the back of the town, where I found larvae in amongst the grass, or must have been bred in the river; here I failed to detect larvae; small fish occurred in the crevices and bays of the bank. The native town is similar to Bathurst, trenches in the streets drain into the river, and in the wet season, in consequence, innumerable breeding-places for mosquitoes are formed. Water is obtained by the natives from the river, as there are no wells. McCarthy Island appears to me to be quite unsuitable to permit of preventative operations against mosquitoes. One must rely on such means as segregation and personal precautions against these insects. This latter method of precaution was, I believe, very successful in the case of Mr. Barnois, who, in 1898, stayed at McCarthy Island for some time without taking malaria fever, a mosquito net being successfully used.

A native Mandingo town, Baia, was visited, and the country round explored. This town was situated two miles away from the river. The country round was perfectly level, most of it being cultivated; ground-nuts, cuscus, and a bean being the chief products. Everywhere the ground was dried up within a radius of two miles; there were no breeding places for mosquitoes within this radius, except one very deep well, forty feet, which had been discarded; in this well only the *Culex* type of larvae occurred. In the huts innumerable quantities of *Anopheles funestus* and its varieties occurred, which could be obtained at any time of the day off the walls. So completely was there an absence of water that, at the margin of a well from which water was constantly being drawn, bees, butterflies, and other insects were present in great numbers, drinking up the water spilt on the ground. At this time of the year the only breeding-places for mosquitoes are in the neighbourhood of the swamps two miles away. Lieut. Young informed me while out shooting that he came across a tub in some fields a short distance from the town in which mosquito larvae were present. I searched along the margin of these swamps, but I failed to obtain larvae here or in the pools dug out for cattle.

III. ENDEMIC MALARIA IN THE GAMBIA

The discovery, both by Professor Koch in German East Indies, and by the members of the Royal Society Malaria Commission in West Africa (1900), of the prevalence of malarial parasites in the blood of native children in an endemic area up to twelve years of age has given us a method by which a correct estimation of the presence and the extent of malaria in a district can be ascertained by the systematic examination of the blood of the children.

While in the Gambia I obtained some one hundred and thirteen children from 0 to 15 years of age for examination; the children were chiefly from the town of Bathurst and a native town seven miles away at Cape St. Mary; a few were also available for examination at a small Mandingo town, Baia, one hundred and eighty-five miles up the river. At Bathurst the children examined were those who came to the out-patient department to be treated for various ailments, or were brought by their mothers, who had come themselves for treatment. Fourteen in all were obtained in this way, only one of them showing signs of fever (101·8°) at the time of examination; some were treated for worms, bronchitis, or injuries. The remainder of the children examined were those who came to be vaccinated at the house of the Public Vaccinator, Dr. Taylor; they were, to all appearance, in good health. At the Cape and Baia the children were brought to me by their parents. The blood of many of the children at Bathurst was examined in the fresh condition, as well as by means of smears made in the usual way on a glass slide; all the smears were stained by a modification of Romanowsky's method, recommended to me by Dr. MacConkey.

From the table (No. I) given below it will be seen that **eighty per cent. of the children examined harboured malaria parasites in their blood,** and these occurred in children practically equally up to ten years of age (the numbers are too small to give correct percentages at the various age periods). After ten years of age, out of thirteen cases examined seven were found infected; in these cases the malaria parasites were rare in the blood; in fact, in all except in one case, the parasites encountered on the films were very few.

TABLE I

Shewing Number of Children in the Gambia Examined and found Infected with Malaria Parasites

Age	No. Examined	No. Infected	Percentage Infected
0-1	18	13	—
1-2	13	11	—
2-3	13	11	—
3-4	17	15	—
4-5	17	14	—
5-6	9	8	—
6-7	4	4	—
7-8	5	4	—
8-9	2	2	—
9-10	2	2	—
10+	13	7	—
	113	91	80
0-5	78	64	82
5-10	22	20	91
10-15	13	7	53·8

Time and opportunity did not permit of the collection of a larger series of cases; it was found especially difficult to obtain children for examination in country districts; still it will be seen that the malaria index in Bathurst is very high, and consequently the chance of infection for the new-comer under suitable conditions is also very great.

It is of interest to note the high percentage of quartan parasites (*Haemamoeba malariae*) among the cases examined, viz., 31·8 per cent., and also the large percentage of crescents (*gametocytes*) observed in the blood, viz., 32·3 per cent., in those cases in which the aestivo-autumnal fever parasite (*Haemamoeba praecox*) occurred. I believe this large percentage has not been observed before on the Coast.

The parasite of tertian fever (*Haemamoeba vivax*) was only found in three cases.

The children infected at Bathurst came from all parts of the town, and no indication was obtained from the examination of their blood that malaria was less prevalent in one street than in another; considering the small size and the equal distribution of suitable breeding-places for the malaria-carrying mosquitoes throughout the town, it is not to be expected that at any one part the malaria index would vary. Table II gives the results of the child examination in the Gambia.

TABLE II

Shewing the Number Infected and Nature of Infection in Children of the Gambia

Children at Bathurst—

Age	No. Examined	No. Infected	Nature of Infection. Remarks
0-1	15	11	(1) Age ten months, blood very watery, aestivo-autumnal ring forms, crescents (in fresh preparation flagellation took place rapidly), pigmented mononuclear leucocytes (2) Age three months, aestivo-autumnal ring forms, pigmented mononuclear leucocytes (3) Age eight months, small aestivo-autumnal ring forms, few crescents (4) Age six months, large and small quartan forms, pigmented mononuclear leucocytes (5) Age two months, many aestivo-autumnal ring forms, one crescent, pigmented mononuclear leucocytes (6) Age seven months, many aestivo-autumnal ring forms, crescents, pigmented mononuclear leucocytes (7) Age eleven months, aestivo-autumnal ring forms (8) Age eight months, few aestivo-autumnal ring forms, one crescent (9) Age ten months, aestivo-autumnal ring forms (10) Age eight months, aestivo-autumnal ring forms, pigmented mononuclear leucocytes (11) Age eight months, many ring forms, double infection of corpuscles, pigmented mononuclear leucocytes Three of the children not infected were under three months old.
1-2	11	9	(1) Many aestivo-autumnal ring forms, pigmented mononuclear leucocytes (2) Ditto (3) Ditto (4) Ring forms, large quartan parasites, flagellating forms in fresh slides, in stained slides many quartan gametocytes, pigmented mononuclear leucocytes (5) Aestivo-autumnal ring forms, pigmented mononuclear leucocytes (6) Ditto (7) Quartan parasites all stages, few gametocytes, pigmented mononuclear leucocytes (8) Aestivo-autumnal rings, numerous pigmented mononuclear leucocytes (9) Few aestivo-autumnal ring forms, numerous pigmented mononuclear leucocytes
2-3	5	4	(1) All stages of quartan (2) Aestivo-autumnal ring forms (3) Ring forms, large forms quartan (4) Very numerous aestivo-autumnal ring forms, pigmented mononuclear leucocytes. This child was an Assyrian; had fever two weeks ago; temperature was 97·4 on examination

Children at Bathurst continued—

Age	No. Examined	No. Infected	Nature of Infection.	Remarks
3-4	5	5	(1) One crescent present (2) Ring forms, large quartan parasite, one crescent (3) Few aestivo-autumnal ring forms (4) Many aestivo-autumnal ring forms (5) Few aestivo-autumnal ring forms, twelve crescents, which had not changed after two hours, were counted in drop of blood, others had flagellated very soon after the blood was drawn	
4-5	9	7	(1) Three crescents in slide (2) Large and small quartan forms, pigmented mononuclear leucocytes (3) Few aestivo-autumnal ring forms, pigmented mononuclear leucocytes (4) Ditto (5) Ditto (6) Ring forms, half-grown quartan parasites, pigmented mononuclear leucocytes (7) Large quartan forms, pigmented mononuclear leucocytes	
5-6	1	0		
6-7	3	3	(1) All stages of quartan parasite, pigmented mononuclear leucocytes (2) Quartan parasites, pigmented mononuclear leucocytes (3) Aestivo-autumnal ring forms, one crescent	
7-8	2	1	(1) Few aestivo-autumnal ring forms, one crescent, pigmented mononuclear leucocytes	
8-9	0	0		
9-10	2	2	(1) Few small and half-grown tertian parasites, tertian gametocytes (2) All stages of quartan parasites	
10-	2	2	(1) Age ten years, only one aestivo-autumnal ring form present in slide (2) Age eleven years, four aestivo-autumnal ring forms present in slide. The ages of the non-infected children were fifteen, fourteen, fifteen years, respectively	

Children of Baia—

Age	No. Examined	No. Infected	Nature of Infection. Remarks.
2-3	3	3	(1) Many aestivo-autumnal parasites (2) Ditto (3) Ditto
3-4	1	1	(1) Few aestivo-autumnal parasites
4-5	1	1	(1) Pigmented mononuclear leucocytes, few aestivo-autumnal parasites
5-6	1	1	(1) Large tertian parasites
7-8	1	1	(1) Few aestivo-autumnal ring forms
10+	3	2	(1) Few aestivo-autumnal ring forms (2) Ditto
	10	9	

Children at the Cape—

Age	No. Examined	No. Infected	Nature of Infection. Remarks
1-1	3	2	(1) A few aestivo autumnal ring forms, two crescents (2) Ring forms, large quartan parasites
1-2	2	2	(1) Ring forms, large quartan forms, quartan gametocytes (2) Three crescents, ring forms, large quartan forms, quartan sporocytes, pigmented mononuclear leucocytes
2-3	5	4	(1) Few aestivo-autumnal ring forms (2) All stages of quartan parasites (3) Aestivo-autumnal ring forms, one crescent (4) Sporocytes, gametocytes, and small forms of quartan
3-4	11	9	(1) Ring forms, sporocytes and gametocytes of quartan (2) Aestivo-autumnal rings (3) Few aestivo-autumnal rings (4) Quartan gametocytes (5) Few aestivo-autumnal ring forms, few crescents (6) Very few small quartan forms, quartan gamecocytes (7) Ring forms, few half-grown quartan forms (8) Few aestivo-autumnal ring forms. In this slide three trypanosomes were present[1] (9) Aestivo-autumnal ring forms, one crescent
4-5	7	6	(1) Few aestivo-autumnal parasites (2) Ring forms, half-grown quartan parasites (3) Small quartan parasites (4) Small quartan form, quartan gametocytes (5) Quartan gametocytes and small forms (6) Aestivo-autumnal ring forms
5-6	7	7	(1) Few aestivo-autumnal ring forms (2) Many aestivo-autumnal ring forms, few crescents (3) Few aestivo-autumnal ring forms, one crescent (4) Few aestivo-autumnal ring forms (5) Ditto (6) Quartan gametocytes and small forms (7) Aestivo-autumnal ring forms
6-7	1	1	(1) A few tertian parasites
7-8	2	2	(1) Aestivo-autumnal ring forms (2) Ditto, few crescents
8-9	2	2	(1) Many quartan gametocytes, few ring forms (2) Few aestivo-autumnal ring forms
9-10	0	0	
10+	5	3	(1) Very few aestivo-autumnal ring forms (2) A few half-grown quartan parasites (3) Ring forms, large quartan forms, and quartan sporocytes
	45	38	

1. See Dutton, *Preliminary Note upon a Trypanosome in the Blood of Man. Thompson Yates Laboratory Reports*, vol. IV., pt. II. Liverpool, 1902.

Presence of the Malaria Parasite in its Definitive Host

Mosquitoes of the *Anopheles* genus were collected for examination from the soldiers' quarters and brought to me by an orderly from time to time in small batches; these were kept from one to three days, to allow of the digestion of the last meal of blood, and then dissected. Out of twenty-seven complete dissections, three mosquitoes were found infected; two of these had zygotes in the stomach wall, three in one and two in the other, from six to ten days old, variety undetermined. In the other infected mosquito, sporozoids were found in the salivary glands, principally in the middle lobes. Out of a dozen mosquitoes (*Anopheles*) caught in the hospital, chiefly from the West Indian soldiers' ward, two were infected. A few zygotes about three days old were found in the stomach in both cases, and were identified as *Haemamoeba malariae*; these two mosquitoes were caught in the dispenser's (native) net three days previously. An examination of his blood was made, but no parasites were detected; he had previously had no symptoms of malaria. It is very probable that these mosquitoes were infected in the town, and not from the soldiers in the barracks or hospital. To obtain *Anopheles* from these places it was necessary to visit the barracks just as dawn appeared, 6 a.m., when they were found on the walls, just over the beds of each soldier; during the day I was never able to detect an *Anopheles* mosquito in this room; they were probably all driven out by the disturbance of rolling up kit, etc., in the morning. The *Anopheles* examined were all *Anopheles costalis*, except three *Anopheles pharoensis*, which were negative.

At the Cape the natives brought me a good number of mosquitoes collected from their huts; nearly all collected in this way were of the *Anopheles* genera, including *Anopheles costalis* and *Anopheles funestus*, the number of the latter greatly predominating.

Twenty-four complete dissections were made, two *Anopheles funestus* being found infected; in one the salivary gland contained sporozoids in large quantities, and in the other four medium-sized zygotes with three empty capsules were present on the stomach wall. Unfortunately, many mosquitoes brought back to Bathurst had died on the way, and were unfit for dissection on arrival.

Other Haemamoebae.—The nature of the expedition did not permit of any extensive investigation on the distribution of other *Haemamoebidae* in the Gambia, still a few animals were examined.

The common yellow and green African canary was universally infected with *Haemamoeba danilewskii* (Halteridium); some tame pigeons from the various factories also showed this parasite in their blood, and also a few birds shot in the bush.

Haemamoeba relicta (Prateosoma) was never found; but the number of birds examined was not sufficient to form an opinion as to the absence of this parasite from the Gambia.

IV. BREEDING-PLACES OF MOSQUITOES IN BATHURST

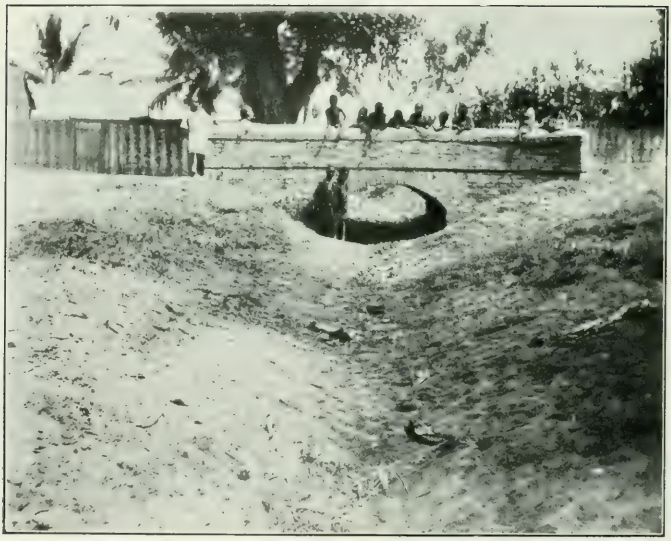
The various breeding-places of mosquitoes which occur in Bathurst can be very suitably grouped under two heads, namely, natural and artificial. The latter are by far the most numerous and important, as many of them occur throughout the wet and dry season, while for at least six months of the year the natural breeding-places have ceased to exist. The following are the chief artificial breeding-places of mosquitoes in Bathurst: —

1.—*Canoes, boats, lighters, and cutters on the foreshore.* The making of boats appears to be a rather extensive industry amongst the natives at Bathurst ; the boats are constructed or repaired on the foreshore, in front of Wellington Street. There is always a large number of these boats lying on the beach ; some of them have been found unfit for repairs and are discarded, others are waiting their turn, it may be, for some weeks, and still others are present waiting to be launched. These canoes and boats collect rain-water, and in the larger boats the amount of water present is very considerable, and often lasts not only between the showers but for a long time after the rains have ceased. In one old boat I found water present four weeks after the last shower in October. In many of the boats the water was from one to two feet deep. On examination, as would naturally be expected, I found these boats almost universally infested with mosquito larvae. **From a rough estimation I made I calculated that each of these boats would produce two thousand mosquitoes per week ; fifty boats of all kinds producing this quantity of mosquitoes is a total of one hundred thousand insects per week distributed into the town.** It will be seen, therefore, that these boats provide excellent and very extensive breeding-places for mosquitoes throughout the wet season and for a portion of the dry. There is no doubt that the houses in Wellington Street derive most of their mosquitoes from these artificial breeding-grounds. The mosquitoes found breeding in these boats were, in order of frequency :—

Stegomyia fasciata
Anopheles costalis
Culex duttoni
Stegomyia albocephala
Culex tigripens

2.—*The Street Drains.* The street drains carrying off surface water have been described as running down the centres of the streets. They can conveniently be arranged under three heads with regard to their capacity for acting as suitable breeding-places for mosquitoes.

(*a*) The large main channels (three to six feet deep by six feet wide), which open into the river at the sluice gates. These drains occur in Hill Street, Alglesea Street, Picton Street, Blucher Street, and the large drain on one



Llewellyn Street drain, near Clifton Road, in the dry season. This drain, being constructed in sand, with no protection against falling in of the sides, allows of the formation of suitable puddles for breeding mosquitoes. *Anopheles costalis* principally breed in this drain. Water collects underneath the low bridges crossing the drain, in which many mosquitoes are found at the end of the wet season.

side of McCarthy's Square. In these drains I was never able to find mosquito larvae during the months of October, November, and the first part of December, although surface water from one-half to three feet deep was always present in them. There is no doubt that the absence of larvae in these drains was due to the large quantities of small fish which are continually swimming up and down the channels in small shoals of from thirty to sixty. The sides of the drains being perfectly smooth, no protection is afforded to the larvae. As the dry weather sets in the water gradually sinks lower and lower in the drains, until water is only present for a distance of twelve to fifteen yards from the sluice gates. This amount of water is present probably throughout the dry season, as it is tidal water which oozes into the drains through the sluice gates. In the process of drying-up, the fish die out or are killed when the drains are cleaned at the end of the wet season. The disappearance of the fish was followed by the presence of mosquito larvae in the water. At the end of December and in January I found innumerable quantities of mosquito larvae in the water in Hill Street drain, near the sluice gates, later, in Alglesea Street drain, and, just before I came away, in Picton Street and Blucher Street drains. These mosquitoes were principally *Culex thalassios*, *Culex duttoni*, and a few *Anopheles costalis*.

(*b*) Shallower drains, made of brick or stone, either partly cemented or not at all, varying from one to one-and-a-half feet deep ; these drains either discharge at right angles to the larger drains or are continuations of them into the centre of the town. They vary with regard to their fitness to act as breeding-places of mosquitoes according to the seasons of the year. In the wet months they are probably free from mosquito larvae, owing to the amount of water passing along them, and thus the small fish would be able to swim up from the main drain. At the beginning of the rains and end of the wet season mosquitoes can breed in them. In October and November I found that after the rain small pools of water collected, owing to the unevenness of the cemented bed of the drain, after the main mass of water had passed away. This condition occurs in the drains of the following streets : Lemon, Hagan, and the town end of Blucher and Picton Streets. The other condition present in these drains, and of more importance than the irregularities in the bed of the drains, is the fact that many of these shallow drains are not completely lined with cement, so that they allow the ground water to percolate into them. This water I found formed a very slow stream along the course of the drain, about one-half to one inch in depth, and was very

suitable for the development of mosquito larvae, which were present here in fair numbers, chiefly larvae of *Anopheles costalis*. This condition obtained, when I arrived in Bathurst, and lasted through the months of October and November, that is, until the level of the ground water had sunk below the bed of the drain. The streets in which these conditions occurred are Dobson Street, Hagan Street, Blucher Street, Hill Street, part of Lemon and Buckle Streets.

(*c*) The other kind of drain occurring in Bathurst is that which has been described as a trench dug along the centre of the streets. These drains either communicate with the big drains or discharge directly into the swamps. It was pointed out that the depth of these drains vary, and that they often are converted into a series of pools by rubbish and sand either thrown into them or by natives walking across. I found these drains to be almost universally infested with mosquito larvae, which occurred in great quantities along their course, and were for the most part all of the genus *Anopheles*; only very occasionally did I find the *Culex* type of larvae in any amount. The small fish, which have been mentioned as being so beneficial in keeping the larger-made drains free from mosquito larvae, though occurring also in many of the grass-choked drains, are here at a disadvantage, the larvae being to a great extent protected by the grass and sticks amongst which they can hide; also pools cut off from the main masses of water occur in which fish cannot gain entrance. **These drains supply Bathurst with the majority of its mosquitoes during the months of September, October, and November.** They occur in the following streets: Fitzgerald Street, the drain runs along the centre of this street from the corner of Kent Street to Box Bar, where it is supposed to empty itself by a channel running down Lovel Place, entering the main drain leading into a swamp. The uselessness of these stretches as a whole are well illustrated by this drain, where I found the outlet completely blocked up with sand and rubbish, so that water would of necessity flow over Lovel Street to get into the swamp, and small fish for this reason also could not possibly gain entrance. Further, the drain itself had been converted into a series of long pools by the natives walking across, carrying with them sand, etc., and, lastly, the thick, rank grass growing in the bed of the drain, together with its naturally small fall, tends to retain the water in it. This drain is bricked across by two or three low, brick arches at the street crossings. Underneath these arches the bed of the drain dips, so that water collects in considerable quantity, which I found contained many *Anopheles* larvae; also, in the course of

One of the central grass-clogged drains at Bathurst in the dry season at a spot where the course of the drain is obliterated by reason of natives walking across; at the end of the wet season this drain is a series of long puddles breeding large quantities of *Anopheles*.

the drain a cemented catch-pit occurs, one foot in depth ; this I also found afforded an excellent place for mosquito larvae. A few other drains in a similar condition to the one described above must be specially mentioned. Commencing at Government House and running behind the Hospital and Telegraph Station is a rather deep drain, which takes the water from a small swamp in this region, discharging into Box Bar by two smaller drains crossing Clifton Road and running through Portuguese Town. In these drains mosquito larvae are very abundant until the end of November, and especially was this the case in the two smaller drains. One of these small drains crosses Clifton Road at the back of the Hospital ; being dug out of pure sand its bed naturally was dammed up by the falling in of the sides of the drain. In the dry season for this reason also the drain becomes practically obliterated. The other drains crossing Clifton Road, nearer the Cemetery, were also converted into a series of pools by the falling in of sand and rubbish. On my arrival, and up to the end of November, these two drains swarmed with mosquito larvae ; from a rough estimation I made during these months I calculated that one larva was present in every four square inches of surface water. These two drains were five hundred feet long, and the water in them on an average was two feet across. From these data one is able to calculate approximately the number of larvae occurring in the drain, and, also, the number of mosquitoes issuing into the town per week from them.

The following are some of the principal streets in which the drains occur :—

Long Street, Grant Street, New Street, Allan Street, Kent Street, Clarkson Street, Dobson Street, Perseverance Street, Prometheus Street, the shore end of Buckle Street, Lemon Street, Picton Street, the town end of Lancaster Street, the swamp end of Hill Street.

In some of these streets the earth dug out to form the drain has been piled up on either side of it, so that the surface of the street falls away from the drain. These grass-overgrown ditches also occur around some of the native compounds in New Town, on the south side of Box Bar, on three sides of McCarthy's Square, and on either side of Clifton Road, bordering Portuguese Town. These drains are certainly to be condemned ; even after heavy rains they appear to allow very little of the surface water to pass along them. Dr. Forde informed me that he has observed very little current in these drains after a heavy shower, and I have made a similar observation. They then collect the rain-water, which stagnates and becomes foul, and only disappears when the level of the ground water sinks below the bed of the ground, that is about two months after the rains. They have been shown to be often

converted into a series of pools by the pouring in of sand, and are often blocked at their outlets in a similar manner, so that fish cannot gain entrance. They thus form excellent breeding-grounds for mosquitoes, and, as I have shown, especially for the malaria-bearing variety (*Anopheles*). The species of mosquitoes found in the drains of Bathurst in order of frequency are :—

Anopheles costalis.
Culex thalassios (in drains containing tidal water).
Culex hirsutipalpis.
Culex duttoni.

3.—*Wells.* During the month of October I found that the wells of Bathurst were not a fruitful source for mosquitoes, though larvae were present in some of them ; still, as a whole, they did not provide extensive breeding-places. After the rains had ceased and as less and less water was to be found in the drains and swamps I observed that mosquito larvae occurred more frequently in the wells. The public wells, some fourteen in all, were examined at various times during October, November, December, and January ; in only one (Lancaster Street) were mosquito larvae found. This well had become foul, chiefly from rubbish thrown into it, and very soon after mosquito larvae swarmed in the water. The native population almost universally obtained drinking water from the public wells, and water is thus being drawn from these wells practically all day long. It would appear from this constant disturbance of the water that these wells were not suitable breeding-places, as I found that in many similar wells in private compounds in which the water was equally good, though less frequently drawn, mosquito larvae were easily obtained. Fifty-five large private wells were examined, occurring in compounds throughout the town ; it was found that those wells which had good covers were almost free from mosquito larvae, while all the others contained larvae in quantities depending on the frequency with which water was drawn from them. The small shallow tub wells occurring in large quantities all over the town were found to contain mosquito larvae, chiefly of the *Culex* kind, in sixty per cent. of those examined during the month of October. It was also noticed that when one of these wells became foul, and from this cause discarded, the larvae occurred in greater abundance ; not a few such tub wells exist throughout the town. It was also noticed how very rapidly the larvae sank to the bottom of the well on the slightest disturbance of the water. All the wells, both public and private, were re-examined systematically in the latter part of December and January by the Sanitary Inspector with the object of determining the percentage in which mosquito larvae occurred. The result is given in the following table up to the time of my departure from Bathurst ; this includes nearly all the public and private wells, and probably about two-thirds of the small tub wells.

	No. Examined	No. of Wells covered	Presence of *Anopheles* larvae	*Anopheles* and *Culex* type larvae	*Culex* type of larvae
Tub wells ...	217	—	—	8	198
Stone wells—					
Public ...	14	1	—	1	—
Private ...	55	13	1	8	35

From the above table it will be seen that over ninety per cent. of the small tub wells already examined were breeding mosquitoes. With regard to the large private wells those in which larvae were found were generally the ones improperly covered. In this connexion it is interesting to record the examination of a large stone well in the yard at the Police Station, which was extremely well covered in, the only entrance as far as one could detect on superficial examination was the small wire gauze lid. In the early part of my stay in Bathurst I had not detected any mosquitoes in the water, in December this well became foul; it was emptied and cleaned, but afterwards the water was worse than ever, having a very strong smell; the contamination was very probably due to a leaking midden in the neighbourhood. Orders were then given that no water was to be taken from the well, and the small lid was locked. Before the filling in of this well was accomplished I examined this well and found mosquito larvae were present in it, and many young mosquitoes dead on the surface of the water. On closer examination of the well I discovered two small holes between the stone rim and wooden cover. These two holes were the only means by which mosquitoes could gain entrance into the well to lay their eggs, but the young mosquitoes apparently had failed to detect these exits and had died in their endeavours to get out through the wire gauze of the lid in the cover. It will be seen how important it is for wells to have a perfectly fitting cover. The mosquitoes which breed in the wells at Bathurst during the latter part of the year are:

Anopheles costalis (chiefly in the large built wells)
Culex fatigans
Stegomyia fasciata
Culex tigripes
Culex duttoni

Breeding-Places Occurring Round Houses and in Compounds

The number of mosquito breeding-places present in compounds was found to vary with the social position of the occupier. In small compounds of the poorer natives, where one or two huts were present, no breeding-places were found. These natives had no discarded bottles, etc., in which water could collect, nor were wells or tubs or any article for the storage of water present, sufficient water for the day being drawn from one of the public wells. These compounds were exceedingly clean and tidy, and no mosquitoes were found breeding in them. Excepting these, breeding-places were found and increased in extent and number in proportion to the wealth and position of the occupier of the compound, reaching a maximum on the premises of the larger traders (natives and white), where innumerable facilities for the development of mosquitoes were afforded. These breeding-places included all those domestic articles which are capable of containing a small quantity of water after showers lasting over a week without being dried up, or are not dried up between the frequent showers in the wet season. Such articles found were broken bottles, either stuck on a wall or scattered over the compounds, iron pots, old calabashes, tin-lined packing cases, cocoanut husks, fowl troughs, and old tins of all sorts. There was found an extraordinary amount of such-like rubbish in some of the factory compounds, the more specialized breeding-places included tubs, used for the storage of rain-water or as wash tubs for bottles, or in which water was placed for the preservation of the tub. Large barrels in which fibres were soaked, garden tubs in which water was stored for gardening purposes, old iron boilers for the collection of rain-water, improperly covered rain-tanks formed other breeding-places. In some of the factories a small gutter six inches across by four feet deep is let into the cemented floor of the yard around the ground-nut store house. This gutter is kept full of water to prevent the entrance of the ground-nut insect into the store. These gutters swarmed with mosquito larvae. In some yards a small channel runs down the centre to drain off rain-water, and is generally covered over with a board. It was found that some of these had become clogged up at intervals with sand and rubbish, so that small pools of water collected along their course; these pools acted as breeding-places for mosquitoes. **An account of an examination of one of the larger European factories will illustrate to what extent mosquitoes are bred by the white man in the tropics on his own premises. In the factory yard were six barrels containing water, in some the water was very foul; in the garden were seventeen tubs containing water for gardening purposes, and besides this number of tubs there were eight small wells, all uncovered. In all these articles mosquito larvae were present; in**

the barrels in the yard the water swarmed with *Culex* and *Stegomyia* larvae, and in the wells and tubs in the garden the larvae of *Anopheles* and *Culex* were found in all of them in good numbers. Besides these breeding-places there were many domestic articles scattered about in odd corners of the yard, which in the wet season would also have acted as breeding-places.

The Species of Mosquitoes Found in Compounds

It was observed that larvae of *A. costalis* were frequently found in rain-tubs and smaller articles containing water. Though many of these larvae may have been originally transferred to some of these articles along with the water drawn from the well, yet the occurrence of batches of larvae of the same age and in fair numbers would tend to show that this species of mosquito avails itself of these small collections of water in which to breed.

Stegomyia fasciata, in tubs and old bottles, etc.
Culex fatigans „ „ especially when the water was foul
A. costalis, tubs and barrels
Culex duttoni
Culex hirsutipalpis
Stegomyia pagens (rare), in ground-nut gutters

The wash-tubs, garden-tubs, wells, and rain-barrels occurring in compounds form the chief source of mosquito in Bathurst for at least six months of the dry season, when all other breeding-places, artificial and natural, have ceased to exist.

Natural Breeding-Places for Mosquitoes in Bathurst

The natural breeding-places for mosquitoes in Bathurst occur for the most part in the swampy districts, namely, Box Bar, Half Die, and the small swamp behind the Hospital; a few natural hollows in some of the streets, more especially those bordering on the swamps, collect rain-water, in which mosquitoes breed.

Box Bar. In the wet season this swamp is covered by a considerable mass of water, which encroaches on to New Town and Portuguese Town and into the centre of Bathurst at Albion Place, the streets in these neighbourhoods being flooded at this season of the year; how far this swamp acts as a breeding-place for mosquitoes in the height of the wet season (July and August) I cannot say definitely, but judging

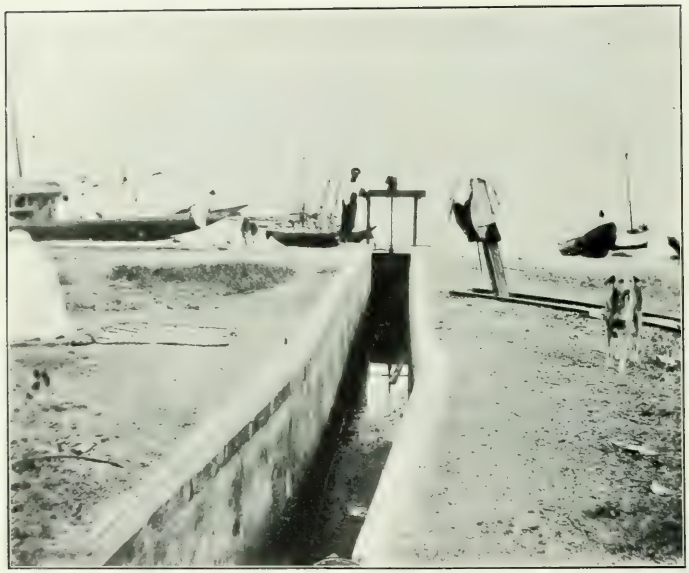
from the conditions which obtain at the end of the wet season, when I personally examined the swamp, I surmised that puddles are formed in the natural hollows of the streets all along the margins of the swamp, namely, Albion Place, Perseverance Street, etc. ; indeed I found, on arriving at Bathurst, remains of puddles in these streets ; some were dried up, others still contained a little water, in which *Anopheles* larvae were present. Box Bar swamp presented some interesting features during the months of October and November. A long, partially constructed central channel runs the length of the swamp, opening by means of double sluice gates into the Oyster Creek at the back of the town. This channel contains a large quantity of water, which overflows on to the swamp after heavy rains. On either side of this channel the land gradually rises one to three feet to Portuguese Town on the one side and New Town on the other ; it is covered with grass and a few low bushes. This land has a very uneven surface ; there are very many hollows and depressions occurring at intervals amongst the grass, and also not a few large round holes three to four yards across, which may have been formed by the natives in obtaining sand ; also, on the borders of the swamp, especially around New Town, trenches occur choked with grass. Lastly, innumerable crab holes are present everywhere, and on to the surface old tins and calabashes are thrown. In the central mass of water I was never able to obtain mosquito larvae, undoubtedly owing to the enormous quantities of small fish which are always present in the water. But in October and November the hollows and depressions mentioned above as occurring amongst the grass contained water, which was cut off from the main channel, and thus unable to drain away, nor could small fish gain entrance ; it was thus to be expected that these pools should contain innumerable mosquito larvae. Three large pools in close relation to this swamp, situated together near the cemetery, must be specially mentioned ; these pools measured twenty to twenty-five feet across, and contained water in December, when the swamp pools proper had completely dried up ; they were used then for watering cattle. As Box Bar swamp dried up these pools became more and more infested with mosquito larvae, though one of them remained free for some time. In it the water was comparatively sweeter than the other two, and small fish were present. As the dry season advanced the water in these pools became exceedingly foul, and enormous numbers of larvae, chiefly *Anopheles*, were found. A long, narrow pool occurs in this neighbourhood, along the side of the cemetery ; this pool communicated with the creek, and is flushed with tidal water ; though the water present in it was foul, and had a distinctly unpleasant smell, no mosquitoes were found breeding in it.

Half Die. This swampy district is drained in a similar manner to Box Bar by means of a central channel opening into the creek by sluice gates. No mosquitoes were ever found breeding in the central mass of water. The swampy surface is much more level than Box Bar, and very little grass is present. Native huts are built close up to the margin of this swamp, practically on all sides, and it is in their compounds

and in the adjoining streets, in which depressions either natural or dug out by the natives occur, in which mosquitoes breed. In these compounds, also, I found many old crab holes containing larvae. Owing to the comparative evenness of the surface, pools formed in this neighbourhood cannot exist for long after the rains have ceased ; by the middle of November there were only one or two natural breeding places to be found. The level of this swamp is being rapidly raised by the deposition of sand taken from the beach ; already the area which has been completed has proved a success. The native compounds built on it were comparatively free from water during the rainy season last year. The remaining swamp to be mentioned is a small one extending from the back of Government House to just beyond the telegraph station, and is limited on the town side by Picton Road. In this swamp water collects in the rainy season and lasts for some time after the rains have ceased, especially in the drain running down its centre which has been previously described ; pools and depressions also occur amongst the grass. This swamp supplies Government House, the Hospital, and other European quarters in this neighbourhood with a considerable number of mosquitoes. The mosquitoes found breeding in the above swamps were in order of frequency : *A. costalis* (the larvae of this mosquito were found in disused crab holes containing water on several occasions, principally in Half Die swamp), *Culex halassios*, *Culex duttoni*, *Culex tigripes*, *A. pharoensis* (rare), *Culex euclastos* (rare).

The swamps described above are not flushed by tidal water owing to the low wall which surrounds the town in their neighbourhood, and also because the sluice gates are only opened at ebb tide ; still a little tidal water gains entrance into the main channel by leaking through the gates.

There is a considerable variation in the number of breeding-places in Bathurst according to the season of the year. In October, when I landed there, the rainy season was rapidly drawing to a close, only a few heavy showers occurred at the beginning of the month. Altogether there was 3·81 inches rainfall. At the beginning of this month all the breeding-places described above were present, at the end of the month practically all the natural and many of the artificial (drains and boats) were dried up. Accompanying this drying up of the breeding-places there was a slight diminution of mosquitoes in some parts of the town (Government House, Hospital, Telegraph Station), but no marked diminution in factory compounds or native quarters. From November onwards, until the commencement of the rains at the beginning of June, the only places in which mosquitoes can breed are wells, tubs, and other articles for the storage of water in compounds, in the tidal water in some of the main drains near the sluice gates, chiefly in Wellington Street, and in the three pools near the cemetery. An examination of the mangrove swamp at the back of the town was made on several occasions, but no breeding-places were found, though some puddles were present which appeared to be suitable. It is very probable that the absence of breeding-places in the mangrove swamp is due to the ebb and flow of the tide and the presence of fish.



The termination of street drain at sluice gate; in the dry season *tidal water* percolates into the drain through the sluice gate; in this water many mosquitoes breed, more especially is this the breeding place for *Culex thalassios*. THEO.

Action of Tidal Water on Mosquitoes

Experiments were undertaken to see how far mosquito larvae would thrive in tidal water; larvae of *A. costalis* of various sizes were taken and were placed in tidal water in large glass jars, and supplied with food. Various percentages of salt water taken from the beach at high tide were added, at the same time control batches of similar larvae were kept in vessels containing the water in which they were breeding. It was found that many of the young and medium-sized larvae died in six to eight hours in the jars containing seventy-five per cent. of sea water, below this percentage they remained alive.

In one experiment in which larvae were placed in undiluted tidal water, one large larva remained alive and changed into a pupa in three days after the experiment started. A garden tub in which mosquitoes had been breeding was emptied and cleaned, and sea water, taken as the tide was coming in, placed in it, the other tubs in the garden being covered with mosquito netting. In four days afterwards a batch of small *Anopheles* larvae was discovered in the water, which subsequently hatched out into adult mosquitoes (*A. costalis*) seven days later. This experiment was repeated with the result that first eggs of *Anopheles* and also *Culex* appeared in one or two days after the tidal water had been placed in the tub, and subsequently adult insects hatched out from them. **From these experiments it would thus appear that certain kinds of mosquitoes can breed in tidal water** if it is not disturbed, and subsequently when the dry season had fully set in, I found larvae in suitable tidal pools, namely, as I have already mentioned, in the drains near the sluice gates in which tidal water had soaked in through the gates. In this water, which contained 1038·5 parts of chlorine per 100,000 parts, I found a few larvae of *A. costalis* and large numbers of *Culex halassios*. On another occasion, in December, I found these mosquitoes breeding in a small hole from which shells had been taken, close to the edge of the water at the mouth of Oyster Creek. The *Culex* were subsequently hatched out from this tidal water, but the *Anopheles* larvae were nearly all infested with a fungus (not identified) which gave them a woolly appearance, and I failed to hatch out any of them. I observed *A. costalis* breeding in a similar salt-water pool during a period in which neap tides occurred. The tidal water in an arm of the central channel in Box Bar, running from the sluice gates to the cemetery, had become converted into a series of small pools by partial evaporation of the water, though at every tide some water leaks through the sluice gates into this channel, but during this period it was not sufficient to replenish this small branch drain. *Anopheles* larvae were found in great numbers in these pools. It is interesting to note, also, that at this time two of the largest pools which were situated close by, and have been described as swarming with mosquito larvae, had been filled in with sand. Samples of water taken from various parts of the town were examined for the amount of chlorine present in them, the result is given in the following table.

Sample of Water	Chlorine per 100,000 parts	Chlorine expressed as percentage of NaCl
1. Public well, New Town, no mosquitoes present in water	161·2	·265
2. Public well, Lancaster Street, water rather foul, *Anopheles* larvae present in numbers	1148·0	1·89
3. Public well in Clifton Road, behind Hospital, no larvae present	186·0	0·3
4. Water (tidal) found in drain near sluice gate, Blucher Street, *A. costalis* and large quantities of *C. halassios* present	1038·5	1·71
5. Small well in private garden, *Culex* present, few only...	27·9	0·04
6. Small well in native compound, Victoria Street, *Culex* larvae present	1145·0	1·88

Mosquitoes Present in the Gambia

The commonest mosquitoes met with in Bathurst were *Stegomyia fasciata* and *A. costalis*. After these may be mentioned *Culex fatigans*, *Culex duttoni*, *Culex halassios*; the latter, a new species, was especially frequent in December and January, and bred in the tidal pools of water as described above. While in Bathurst I never saw specimens of *A. funestus*. Out of a series of *Anopheles* which had been bred, or captured in various parts of the town, Mr. Theobald has failed to detect one; on the other hand, at Baia and McCarthy Island, in the Hinterland, I did not obtain a single *A. costalis*; here all the *Anopheles* caught were the small *A. funestus* and its varieties. At Baia, out of two hundred mosquitoes brought to me by natives, all were *A. funestus* except one; these mosquitoes could be caught at any time of the day in the native huts, they were found resting on the wall, some had evidently fed not many hours previously; the ovaries were in all stages of development. At McCarthy Island I found, at 1 p.m., a great many *A. funestus* on the walls of a room in Government House in which a European slept. No other kind of mosquito was present. At Baia and McCarthy Island, in December, when everything is dried up, the river and a few marshes were the only available breeding-places. At Baia the river was three miles away from the town, and the only marsh near was two miles away. The only breeding-place in the native town was an old disused well, which was found to be thirty-four feet deep; at this depth only *Culex* larvae were found in the water. At McCarthy Island I never found mosquito larvae in the river, but in a swamp half-a-mile away from the town they occurred in great numbers. At the Cape, where a similar marsh to the one on McCarthy Island occurred, *A. funestus* was the chief mosquito found in the native town; but here *A. costalis* was also present in

small quantities. The specimens obtained were caught chiefly in the European compounds. At the Cape a few artificial breeding-places were found in compounds. It would appear then that *A. funestus* and its varieties are rural mosquitoes, and require rather special breeding-places, while *A. costalis* is essentially a town-bred mosquito, and capable of utilizing any small collections of water for breeding purposes. At Bathurst I obtained one single specimen of the genus *Panoplites*, which was caught in the prison (*P. uniformis*, Theobald). This species of mosquito was never found breeding around Bathurst, and these mosquitoes were only seen in the marshes at McCarthy Island and Baia. Here they occurred in considerable numbers, and attacked natives and whites crossing the marsh at all times of the day in a very vicious manner. The observation of Durham and others with regard to *Stegomyia fasciata* was fully confirmed at Bathurst ; these mosquitoes only bite during the day, more especially in the early part of the afternoon. None of this species were collected in mosquito nets during the night. As yet we have no method by which any approach to the exact estimation of the number of mosquitoes in a district can be ascertained, although a rough estimation may be got from the number and extent of the breeding-places ; also the presence of mosquitoes at times when no breeding-places can be found, can be demonstrated by the construction of artificial pools as described by the Members of the Royal Society's Malaria Commission. No reliance can be placed on the statements of the white man in Africa as to the presence, or absence, or number of mosquitoes in the district. Many men become immune to the bites of mosquitoes after a time, and on the other hand, one or two importune mosquitoes cause as much annoyance as many. With the object of obtaining some idea of the number of mosquitoes entering a house at night, I employed the mosquito net method, which was found so useful by the Members of the Liverpool Malaria Expedition to Nigeria, in detecting the presence of mosquitoes in the absence of breeding-places. The Hospital was selected as the site for the experiment, and a net free from holes was rigged up over a bed in one of the wards, in which one of the orderlies or native patients slept. The net, instead of being tucked under the mattress in the usual way, fell short of the bed clothes, a space of two to four inches being left between the edges of the bed and the bottom of the net. The net was put down every night before the sun went down. During the evening, mosquitoes obtaining entrance below after feeding would climb to the top of the net. These were collected about 6 a.m. in the morning by myself or an intelligent orderly who brought them to me. Mosquitoes failed to find exit in nets rigged up in this manner even when they have become quite lively. The result of the experiment, which is given in the following table, was carried on throughout the months of November, December, and part of January. Though this method is as yet very imperfect it might be useful and interesting to rig up a similar net in the wet season, and to compare the numbers caught at the time. During the time this experiment was

proceeding it must be remembered that all the natural breeding-places near the Hospital where completely dried up, and in the Hospital compound itself no artificial breeding-places occurred.

Mosquito Net Experiment

Date	No. present in net each day	Remarks	Date	No. present in net each day	Remarks
Nov. 1	3	1 *Culex*, 1 *A. costalis*, 1 *A. pharoensis*	Dec. 17	0	
„ 13	0		„ 18	1	*Culex*
„ 14	0		„ 19	2	*A. costalis*, *Culex*
„ 15	0		„ 20	1	*A. costalis*
„ 16	1	*Culex*	„ 21	0	
„ 17	1	*A. pharoensis*	„ 22	1	*A. costalis*
„ 18	1	*Culex*	„ 23	2	*Culex*
„ 19	3	All *Culex fatigans*	„ 24	0	
„ 20	3	*Culex*	„ 25	0	
„ 21	3	All *A. costalis*	„ 26	2	*A. costalis*
„ 22	7	3 *A. costalis*, 4 *Culex*	„ 27	7	All *A. costalis*
„ 23	1	*Anopheles*	„ 28	0	
„ 24	2	*Culex fatigans*	„ 29	4	*A. costalis*
„ 25	2	*Culex*	„ 30	3	„
„ 26	1	*A. costalis*	„ 31	1	„
„ 27 to Dec. 3		Away up river, mosquitoes not collected	Jan. 1	2	„
			„ 2	1	„
			„ 3	2	„
„ 4	0		„ 4	1	„
„ 5	0		„ 5	1	„
„ 6	0		„ 6	2	„
„ 7	3	*A. costalis*	„ 7	0	
„ 8	2	1 *A. costalis*, 1 *Culex*	„ 8	0	
„ 9	0		„ 9	0	
„ 10	0		„ 10	0	
„ 11	1	*A. costalis*	„ 11	5	1 *Culex*, 4 *A. costalis*
„ 12	0		„ 12	0	
„ 13	0		„ 13	3	*A. costalis*
„ 14	2	*A. costalis* and *C. fatigans*	„ 14	2	„
„ 15	2	*Culex*	„ 15	1	„
„ 16	2	*A. costalis*	„ 16	2	*A. costalis*, 1 *Culex*

V. PREVENTION OF MALARIAL FEVER IN THE GAMBIA—DESTRUCTION OF MOSQUITOES

Practical measures against malaria have already been briefly referred to in an earlier part of this report. It remains now to consider how far these measures are applicable to the conditions which obtain in Bathurst. For convenience we may consider them under two heads :—

1. Measures for protection of the individual—individual precautions.
2. Measures for the protection of the community.

Preventive measures, including the prophylactic use of quinine and the various methods for the prevention of bites from mosquitoes, which can be adopted by everyone in the tropics, have already been carefully described and summed up by various writers, so that little need be said here. *There is no doubt that the number of bites from the Culicidae in the tropics can be greatly diminished by the careful use of the mosquito net, and thus the risk of infection from malaria lessened. But even this simple measure, as other observers have said, is astonishingly neglected and abused in Africa, and this abuse, unfortunately, is greatest among the European traders and their clerks, where the chance of malarial infection is greatest.* It is curious to note, after very careful demonstration in the way in which the net should be used, how soon one finds the nets of the Europeans acting as mosquito traps. In Bathurst a few of the Europeans have anti-mosquito bedrooms ; they are on the whole good, but great care will be necessary to keep them free from holes, as they are made of mosquito netting ; also the 'boys' are very apt to leave the doors open during the day, thus allowing the entry of mosquitoes. I understand that Government will soon supply all the officials with a mosquito-room, and there is no doubt that with care they can be used with some measure of success. In this connexion it would be a great advantage if the ward at the hospital in which the European patients are treated were made mosquito proof. Mosquito nets over patients' beds are unsatisfactory, owing to the necessary disturbance which takes place in connexion with the treatment of the patient. Besides the precautions directed against mosquitoes, there is no doubt that exercise and fresh air helps one, and in Bathurst special facilities exist for such exercise. There is a fairly good road for cycling, driving, or riding ; and amongst games, tennis, cricket, and even football may be played. It is probable that it will be some time before the malaria mosquito investigations will be appreciated by the white man in Africa, and even when this desired result is attained, one cannot rely upon the

individual to protect himself against malaria. Therefore an important matter presents itself for consideration in each West African Colony, namely, how far can the white population be protected and to what extent can suggested measures be made applicable to the various districts and towns in the Colony? The three most important suggestions which have been put forward for this purpose (the protection of a country) are :

1. The destruction of the malaria parasite in the intermediary host (man) by means of quinine.
2. Segregation.
3. Destruction of the mosquito.

Koch first suggested the administration of quinine on a large scale, and applied it with some success to communities in German East Indies. In Africa, at Lagos, quinine is given gratuitously to the natives. This measure to be efficient must be energetically carried out, that is, each individual member of the community harbouring malaria parasites must be dosed with the drug. Neglecting the large expense it would entail this measure alone is not applicable in Bathurst, it would be difficult to carry out in an efficient manner. It would be impossible, until education has further advanced, to get the natives to submit to such treatment without using force.

In Bathurst, the valuable method of segregation is not feasible, as the town is already laid out, and good houses, occupied by Europeans, are situated in many of the streets, and surrounded by, as a rule, equally well-built native quarters ; still, in a small way, in one part of Bathurst this measure could be applied, namely, to the piece of land extending from the beach to Clifton Road, on which are situated Government House, Hospital, and other European quarters ; this area should be kept free from the native huts. The method of segregation is applied to some extent among the European Commissioners, their huts at the various native towns being built three hundred yards away from the native compounds. The segregation principle should also be adopted when new administrative quarters are built in the Colony, new bungaloes should not be erected within a distance of half-a-mile from the native quarters ; this rule should also be seriously considered by the European traders choosing a site for a new depôt.

The last method, which has been so ably advocated by Professor Ross, deals with the destruction of the mosquito by the elimination of its breeding-places. In this method the point aimed at is to reduce the number of all species of mosquitoes in certain suitable districts ; it appears to me that the town of Bathurst is especially suitable for the accomplishment of such a measure. It is situated as described on a practically isolated piece of land surrounded on nearly all sides by a broad expanse of water. The amount of land to be dealt with is comparatively small, namely, about a square mile, the surface is fairly level and sandy, readily absorbing water. In this area the breeding-places of mosquitoes are a known quantity, the artificial (those made by man) being in excess of the natural. The rainfall for a tropical country is

very small, and rain occurs only in four out of the twelve months of the year. Finally, in the dry season, as already stated, the breeding-places of mosquitoes occur only in the various yards and compounds. Excluding malaria, there are other reasons why an attempt at the destruction of mosquitoes should be undertaken in Bathurst, the close proximity of Dakar and St. Louis in the Senegal, at which places epidemics of yellow fever have broken out from time to time, is a danger to the inhabitants of Bathurst (in 1900, at Dakar and St. Louis, there were four hundred and ninety-five cases of yellow fever, with two hundred and twenty-five deaths), thus the probability of yellow fever being introduced into Bathurst from these ports by traders and others,* and its spread amongst the Europeans in this town by the means of mosquitoes is not to be disregarded. There is yet another disease very prevalent in Bathurst which is also spread by means of mosquitoes, namely, Filariasis. An examination of the blood of a number of the inhabitants revealed the presence of filarial embryos in thirty-four per cent. of those examined. Cases of Elephantiasis are frequently seen in the streets of the town. In Bathurst it is thus especially needful to diminish as far as possible the number of mosquitoes which infest the town.

In chapter IV, I have described the various mosquito breeding-places occurring in Bathurst ; here it remains to discuss the methods most suitable for their abolition.

Artificial Breeding-Places. The discarded domestic articles, including tins, bottles, calabashes, etc., must be collected and removed from all compounds in the first instance, and provision against their re-accumulation is necessary ; this might be accomplished by a systematic collection under the supervision of the Sanitary Board. The rain tanks and barrels for the storage of rain water require well-fitting covers ; such tanks should not be allowed in compounds without anti-mosquito covers, as not only do they breed mosquitoes, but the stored water soon becomes foul by dust, dirt, and insects which collect in them. Water tubs required for the soaking of fibres should be completely emptied at least once a week, and refilled with fresh water. As a further safeguard, kerosine oil should be applied to the surface of the water when the tub is refilled. Tubs for the storage of water for gardening purposes should be limited in number, and only sufficient water for the day ought to be stored in them. These tubs should be completely emptied of water by turning them upside down every day ; if this is not done a very considerable quantity of mosquito larvae are likely to remain in the small quantity of water left in the bottom of the tub. Gutters round the ground-nut stores, when filled with water, should be treated at the same time with kerosine oil, an ounce of which would probably be sufficient for each gutter.

Boats. The following methods of dealing with boats naturally suggest themselves : old boats and canoes should not be allowed to remain on the beach, such discarded boats should be broken up. Boats awaiting repairs should be turned bottom uppermost, larger boats and hulks, staying short periods on the beach, should be carefully

* See Chapter I

inspected, the rain water collected in them should be baled out as much as possible, and, in addition, kerosine oil or other culicicide should be applied, as it is impossible to bale out all the water from such boats, and even in a very small quantity of water many mosquitoes can breed; the boats on the shore should be inspected at least once a week.

Wells. There is no doubt that in Bathurst there is an excess of small tub wells out of proportion to the requirements of the natives. In the first instance, in dealing with these wells their number should be reduced; this could be accomplished by filling in these wells as they become foul (a condition of affairs which often occurs), and prohibiting the digging of new wells without the consent of the local authority. A better plan would be to do away with the majority of the native tub wells and, in their stead, to increase the number of public wells, properly covered and under the control of the sanitary authority. Dr. Forde has devised, as a preliminary measure to control the breeding of mosquitoes in these small wells, a very ingenious cover, which also could be utilized as a cover for rain tubs and barrels. This cover consists of a large iron hoop obtained from discarded barrels, to which is fastened all round a piece of stout calico or sacking free from holes, in such a manner that a good deal of sag is left in the material. After water is obtained from the well the hoop is thrown over the mouth, and the calico catching on the rim of the well completely closes the entrance and is kept taut by the weight of the iron hoop. This cover is so simple, and, however carelessly applied, must effectually close the entrance of the tub against mosquitoes, that I think it is well worthy of extensive use in the town. Dr. Forde had lately informed me that these covers are now being made in Bathurst, and are sold to the natives for the sum of fourpence. Another method which I believe to be feasible, and certainly applicable to the larger private wells, is to stock them with fish; indeed, I came across four wells in Bathurst in which fish were present, and in which I could never detect mosquito larvae. The fish in these wells had been obtained from one of the large drains in the town; unfortunately, I do not know the species. With regard to the large private wells, it is very essential that these should have proper anti-mosquito-proof covers.

Street Drains. It appears to be unfeasible to allow the open street drains to act as drains for subsoil as well as surface water; in fact, many of the larger drains have been well cemented to exclude sub-soil water. From the anti-mosquito point of view it is very desirable that the central street drains should only be utilized for carrying away surface water. It has been shown that when sub-soil water percolates into these drains a most suitable condition for the breeding of mosquitoes is brought about. It is therefore necessary that the bed and sides of the street drains should be well cemented. Many of the shallow drains require attention in this respect. Catchpits in the course of the drain are useless and should be abolished, and also the dips in many of the drains occurring underneath the small bridges at the corners of the streets. Frequent brushing

Raising the level of Halt Die Swamp by deposition of sand taken from the beach.

out of the drains at the close of the wet season would be helpful for the purpose of removal of the small pools of water which collect in some parts of the bed of the drain. Special care ought also to be taken to provide for the entrance of fish, which have been shown to be such excellent mosquito scavengers. The centrally situated grass-clogged drains ought to be abolished; as drains they are inefficient, and as they form the chief source of mosquitoes in Bathurst at certain times of the year, they urgently require attention; many of them could be got rid of by filling in with the earth and sand piled up on either side of these drains. Their place should be taken by superficial saucer-shaped drains. The filling in of these drains will take some little time, and it will be necessary to adopt some method in the meantime to prevent, or at least to diminish, the numerous mosquito larvae infesting them. The only feasible way will be the employment of labourers to keep the drains free from long grass and rubbish, and the intelligent application of kerosine. Also special attention should be taken to keep the mouths of these drains free from rubbish, so that small fish can gain easy entrance to them.

Natural Breeding-Places. The abolition of the breeding-places occurring in the swampy districts of Bathurst is a work which will take some time, and consists practically of raising the level of the swamps by the deposition of sand, together with a proper system of drainage. At Half Die swamp the process of filling in was being pursued with great rapidity during my stay at Bathurst, and a great portion of this area has been raised two or three feet; still there is a large area of a swampy nature in Bathurst to be treated in this manner, and until this is accomplished it will be necessary to provide some other method of ridding these districts of mosquito breeding-places. In this connexion, it must be remembered that mosquitoes do not breed in the central mass of water in the swamps, this water being disturbed by winds, the rise and fall of the tide (to some extent), and, also, it is well stocked with fish, so the mosquito breeding-places to be dealt with will be found along the borders of this water, and will vary in position according to the height of the water in the swamp.

Mention has been made of the holes, irregularities, ditches, and large pools which occur on the borders of the swamps (chiefly Box Bar swamp), and in which it was shown mosquitoes bred in great quantities. Such-like breeding-places could be dealt with by filling them up with sand—the number of them is not very great; around the borders of Box Bar, for instance, there are only about fifteen of the larger holes to be dealt with. This work could easily be accomplished during the dry season by a few labourers. During the rains special inspection should be made of the borders of the swamps, and the breeding-places found treated with kerosine or other oil; I believe that the application of kerosine in an intelligent manner would produce some good results, nor do I think the cost would be very great. In the streets bordering on the swamps, holes and irregularities occur, but more especially are they found in the native compounds in these situations, and in the rainy season, when the swamp water is high,

breed many mosquitoes. Such streets and compounds urgently require attention, and I would specially mention in this connexion Albion Place, Prescot Street, Perseverance Street, and other streets around Box Bar. The natives themselves in these districts could do a great deal by raising the level of their compounds by the deposition of sand and shells, indeed, some of the compounds have been raised in this way with beneficial effects. There is one small swamp, namely, that behind Government House and the hospital, which urgently requires filling in, because in this neighbourhood a good number of Europeans are stationed, and it is from this swamp that they obtain the majority of the mosquitoes occurring in their houses.

To carry out the above suggested measures of dealing with mosquito breeding-places in Bathurst, it will be necessary in the first instance to appoint a small permanent sanitary staff for the purpose, whose sole work would be to destroy existing breeding-places and to prevent their recurrence. The sanitary staff should be under the control of the sanitary board, and its movements directed by the colonial surgeon ; it should at least consist of one inspector having a good knowledge of the mosquito, its larva, and its breeding-places ; under him a small gang of workmen, who could easily be taught to distinguish mosquito larva, and a cart for the removal of rubbish, tins, etc., from the various compounds would be required. The men, besides this work, would be employed in filling up holes and depressions, brushing out drains, and applying culicicides when required. It is especially necessary that such an inspector should understand when and where culicicides ought to be employed. Before any systematic work is undertaken, a preliminary removal of rubbish from houses and compounds and factory yards is essential. The rubbish so collected, which consists of old tins, bottles, iron pots, etc., will be of some value, as it can be utilized to fill up hollows and pools occurring throughout the town. After this preliminary removal, the work of the sanitary inspector will be :—

1. A systematic weekly inspection of all houses and compounds, for the purpose of searching out and dealing with breeding-places and preventing the accumulation of old tins, etc.
2. Systematic inspection of the street drains and boats on the foreshore.
3. Similar systematic inspection for natural breeding-places round the margins of the swamps.

Many of the breeding-places found in this way can be immediately destroyed by the inspector by one or more of the methods described above, others more difficult to deal with would have to be reported to the colonial surgeon.

The work of the anti-mosquito staff will naturally vary according to the season of the year. The inspection of yards and compounds must necessarily go on week by week all the year round, as mosquitoes are breeding in these places at all seasons of the year. A great deal of information will have to be obtained by the preliminary inspection as to which compounds are the most productive of mosquitoes,

Preliminary filling in of a grass-clogged ditch at Bathurst with old tins, scrap iron, etc., collected from compounds in the town, the source of many mosquitoes, chiefly of the *Anopheles* genus.

and such will require special attention. The public should be encouraged to report to the inspector when the mosquitoes are troublesome in order to help on the work.

The town drains will require special attention at the beginning, and more so at the end of the wet season (October and November), and it will be probably necessary to increase the staff of workmen at these times to keep them free from larvae, especially the grass-clogged drains. In the dry season (for seven months) they need scarcely any attention, with one most important exception, viz., the main drains to the sluice gates ; in these it has been shown that sea water collects at this time of the year, and in it many mosquito larvae are found ; regular application of kerosine oil to these drains, I believe, would be the most feasible method of treatment.

In the dry season, also, no special inspection of the swamps is necessary, as they are dried up at this time, but holes and depressions which have been found to act as breeding-places in the wet season can now be filled in with sand, etc., by the workmen. The swamps will require attention like the drains, more especially at the beginning and end of the wet season, when pools are shut off from the main mass of water ; I believe it will be found that in the height of the wet season few mosquitoes breed in these swamps. At this time the swamp is practically an open sheet of water exposed to winds, and is well-stocked with fish ; it will thus probably be more necessary to pay attention to the hollows in the streets and compounds bordering these swamps.

It cannot be expected that Bathurst will be appreciably freed from mosquitoes at once, solely by the energies of the mosquito brigade, because, it must be remembered, breeding-places occur which require more special attention than others ; for example, it will probably be necessary to deal with the small private wells and boats on the foreshore by legislation : also engineering work, such as levelling streets, making proper street drains, and filling in the swamps will necessarily take some time. **Still, Bathurst, by means of the special anti-mosquito staff, can certainly be made as free from mosquitoes all the year round as it is in the height of the dry season ; and, further, there is every reason to believe that mosquitoes can be diminished in numbers to a great extent, more especially by means of the house-to-house inspection.**

VI. THE COMMENCEMENT OF THE CAMPAIGN AGAINST MOSQUITOES IN BATHURST

In the early part of November, a preliminary report upon the sources of mosquitoes in Bathurst was submitted to His Excellency the Acting Governor, H. M. Brandford-Griffith, Esq. In this report the mosquito breeding-places of Bathurst were described, and methods applicable for their extermination were discussed; it was pointed out that the inauguration of a crusade against mosquitoes in Bathurst offered every hope of success, and at the same time, it was urged that any measures adopted in this direction should be of a permanent nature, and considered part of the sanitary work of the town.

On November 5, His Excellency very kindly gave the colonial surgeon, Dr. R. M. Forde, and myself an opportunity of discussing with him the various matters referred to in the report. At this meeting I was informed of the desire on the part of the Colonial Government to enter upon a crusade against the mosquito, and to undertake the necessary work. Soon after this date the plan of campaign was arranged; Mr. Thomas, the sanitary inspector, was selected for the part of 'anti-mosquito' inspector, and received special instruction in the work; an assistant inspector was appointed to take his place for the ordinary sanitary duties. A gang of ten of the sanitary board labourers, including one head-man, was appointed for special duty, and one of the sanitary carts was set aside for the work.

It was decided, in the first instance, to remove all the old tins, pots, and other rubbish from all yards and compounds; to this end notice was posted up throughout the town, informing the people of the nature of the work and inviting their co-operation and help.

On November 18, the preliminary removal of rubbish from the various compounds began. The work was started in Wellington Street, where most of the large trading stores are situated. At the outset the progress was slow, as the process of ridding these large business premises of discarded tin boxes and bottles took some time, in fact, at some of the factories it required two days to accomplish. After Wellington Street had been depleted of rubbish the work progressed more rapidly, from many of the compounds the natives had collected their old tins and pots and placed them in readiness for the sanitary carts, though, as was to be expected, it was found that many such-like articles were left behind in odd corners.

The rubbish thus collected from the compounds was utilized to fill in a deep

trench running behind the hospital, which has been already mentioned as being an excellent breeding-place for the mosquito; the old tins, which were well battered down, were then covered with sand from the shore.

After the removal of the rubbish from the larger compounds had been completed, a small gang of the labourers were employed in filling in two large pools near the cemetery, which were found breeding mosquitoes in great quantities; the third pool was left for a while until it could be replaced by a well, as this pool was required for the purpose of watering cattle. Besides this work a few foul wells were filled in. *Up to my departure from the Gambia, January 10, three hundred and sixty-three houses and compounds had been inspected, and from them one hundred and thirty-one cart loads of old tins, pots, and other rubbish were removed, and about two hundred and thirty yards of the trench behind the hospital had been filled in.*

On the return of the governor, Sir George Denton, K.C.M.G., about the middle of December, other matters in connexion with the work were considered. It was decided that the work which had been started should be a permanent sanitary measure—*i.e.*, an inspector and sufficient labourers should be employed solely for the purpose of dealing with the destruction of mosquitoes. For this end the grant for sanitary work was increased to the extent of £200 per annum, and this annual amount was to be devoted to the work.

An ordinance was drawn up and passed by the legislative council in the early part of January, 1902. In this ordinance, which is to amend the Public Health Ordinance, 188-, powers were sought to enable the Governor in Council to make rules and regulations for various sanitary purposes. Some of the sections are of the utmost importance for the carrying on of the campaign against mosquitoes in Bathurst, because by them certain artificial breeding-places can be dealt with in a more thorough manner.

The sections relative to the anti-mosquito work include the following:—

11. *Breeding-Places for Mosquitoes*

Making provision for the removal, filling, or covering up of all drains, ditches, pools, swamps, holes, pits, depressions, cisterns, wells, tanks, barrels, tins, bottles, or broken pieces of bottles, and generally all receptacles, things, or places whatsoever, whether of a like nature to those before mentioned or otherwise, which are, or may be, capable of becoming breeding-places for mosquitoes or other noxious insects; and for the prevention (by the imposition of suitable penalties on the occupiers or owners of the premises on which the same are found, or other persons responsible) of the occurrence, accumulation, or continuance thereof.

12. *Wells*

Prohibiting or rendering, subject to conditions, the digging of wells in private compounds, and making provision for the cleansing, repairing, building up or re-building on proper principles of wells presently existing; also for the covering and keeping covered with wire-gauze lids, close pumps or other contrivances, as may be prescribed, of all wells whatsoever.

13. *Removal of Sand, etc.*

Preventing the removal or carrying away of any sand, shingle, rock, gravel, soil, or artificial protection from any part of the foreshore, or from any beach, bank, or public place whatsoever, without permission from some proper authority in such regulations to be indicated.

15. *Removal of Hulks*

Removing from any shores or beaches and open spaces, when thought advisable, all hulks, cutters, boats, canoes, timber, casks, rubbish, or any obstruction or objectionable article or thing whatsoever; or requiring the removal thereof by any persons judged to be responsible therefor.

17. *Inspection of Premises*

Providing for the inspection from time to time, and as often as may be thought expedient, of all lots, compounds, dwelling-houses, sheds, buildings, and premises whatsoever by such officers or persons as may be prescribed; subject to such conditions, safeguards, and requirements, whether as to obtaining an order under the hand of some Justice, the Chief Magistrate or other authority, or otherwise, as may be prescribed.

Dr. Forde informed me, in a letter dated February 17, that the removal of old pots and pans, etc., throughout the town had been completed, and that the inspector had now begun his regular weekly inspection of yards and compounds; also a gang of men had started filling in some of the grass-clogged drains, and the filling in of all large pools near the cemetery had now been accomplished.

I understand also that special sanitary regulations have been drawn up, but as yet I have not seen a copy.

REGULATIONS UNDER SECTION 2 OF THE PUBLIC HEALTH AMENDMENT ORDINANCE, 1902
(No. 1 of 1902)

I. (1) The occupier, and if no occupier, then the owner, of any lot, yard, compound, or other parcel of land whatsoever, shall fill up, or cause to be filled up, all drains, ditches, pools, holes, pits, irregularities, and depressions in the ground or surface of such lot, yard, compound, or parcel of land which may be of such a nature as to cause the accumulation or stagnation of water.

(2) No person shall, unless for building or other necessary or reasonable purposes, dig or make any drain, hole, irregularity, or depression in any portion of ground whatsover so as to cause or allow the accumulation or stagnation of water; all building and other such operations shall be conducted in such a manner as, so far as possible, to avoid causing such holes, irregularities, or depressions as aforesaid.

(3) Sand for making mortar or other building purposes shall in no case be taken out of the ground or soil of any lot or compound, but may be taken from the beach below or near low water mark.

II. (1) No person shall place on any wall or building, any bottles, or broken pieces of bottle, or other articles unless broken into small fragments so as to be incapable of containing water.

(2) The occupier, or if no occupier, then the owner of any building, or of any lot, yard, compound, or parcel of land whatsoever, shall cause all bottles, broken pieces of bottle, and other articles on or attached to such wall or building to be removed or broken into small fragments so as to be incapable of containing water.

III. The occupier, or if no occupier, then the owner of any lot, yard, compound, or parcel of land shall, on being required so to do by a notice under the hand of the Chairman of the Board of Health, cause all discarded tins, pots, bottles, calabashes, and all other discarded articles capable of containing water in or on such lot or parcel of land to be collected in readiness for removal by the carts of the Board of Health.

IV. The owner of any premises wherein there is now, or may hereafter be dug, any well, shall within thirty days after service upon him of a notice under the hand of the Chairman of the Board of Health requiring him so to do, cover such well with a wooden, wire-gauze, or other cover to the satisfaction of the Inspector of Nuisances.

V. The occupier, and if no occupier, then the owner, of any house, shed, or other building whatsoever, or of any lot, yard, compound, garden, or other parcel of land whatsoever, shall cause every cistern, tank, barrel, or other receptacle whatsoever holding or capable of holding water on such premises to be maintained in such a manner as not to be or to be capable of becoming a breeding-place for mosquitoes or other noxious insects.

VI. All hulks or boats hauled up on any beach or open space within the town of Bathurst, shall, so far as possible, be turned keel upwards; boats in course of construction or undergoing repair shall be exempt from this requirement, provided always that such construction or repairs are carried on with reasonable expedition, and the boats are not allowed to become breeding-places for mosquitoes by the accumulation of water therein.

In cases where it shall be found impracticable to turn any lighter or boat keel upwards, it shall be the duty of the owner thereof to take due and sufficient measures to the satisfaction of the Chairman of the Board of Health to prevent the accumulation of water therein.

'Boats' in this regulation shall include canoes, cutters, and any other small craft whatsoever.

VII. The owner of any bakehouse shall once in every six months cause the complete inside of such bakehouse to be whitewashed.

VIII. Section 49 of the Public Health Ordinance, 1887, shall be construed and is hereby declared to apply to the entry of premises for any purpose whatsoever connected with the due sanitation thereof and the enforcement of any requirement or prohibition in the said Ordinance or hereinafter in these Rules contained.

Any costs or expenses incurred in obtaining an order under the hand of the Chief Magistrate or of a Justice of the Peace as in the said Section provided, shall be recoverable against the occupier or owner of the premises in like manner as other costs and expenses are recoverable under Section 112 of the said Ordinance.

IX. If on the complaint of one or more residents it shall appear and be ascertained to the satisfaction of the Chief Magistrate or two Justices of the Peace that any person has been annoying such complainant or complainants or others by unreasonably, and at late hours of the night, playing upon any string, brass, or other musical instruments, or by singing, the Chief Magistrate or the two Justices aforesaid may in their discretion dismiss such offender with a warning, or if the offence appear to him or them to have been of repeated occurrence, whether before or after such warning, or attended by any aggravating circumstances whatsoever, fine such offender in such sum as they shall consider suitable, not exceeding ten shillings.

X. Canes shall not be dragged along Russell Street or Wellington Street.

XI. Any person contravening or wilfully or negligently failing to comply with any of the provisions contained in these regulations after service on him of a notice to that effect, under the hand of the Chairman of the Board of Health, shall be liable on conviction before the Chief Magistrate or two Justices of the Peace to a penalty which (save where it may be otherwise provided in the case of any particular offence) shall extend to, but not exceed, the sum of five pounds for any one offence, or in default of payment thereof to imprisonment with or without hard labour for any period not exceeding one month.

Passed in the Executive Council this Seventh day of July, 1902.

GEORGE C. DENTON, *Governor*

APPENDIX

REPORT ON A COLLECTION OF MOSQUITOES OR CULICIDAE, ETC., FROM GAMBIA, AND DESCRIPTIONS OF NEW SPECIES

By F. V. THEOBALD, M.A.

THE collection of Culicidae and other blood-sucking Diptera, made by Dr. Dutton during his visit to Gambia, contains some three hundred Culicidae, included in the following genera: *Anopheles*,* *Stegomyia*, *Culex*, *Mansonia*, *Uranotaenia*, and *Corethra*. Altogether there are seventeen species of Culicidae as follows: three *Anopheles*, three *Stegomyia*, seven *Culex*, one *Mansonia*, and a single *Uranotaenia* and *Corethra*. There is also a distinct variety of *Anopheles costalis* and *Anopheles funestus*. Besides Culicidae, there are some specimens of Psychodidae, or Owl Midges, of the genus *Phlebotomus*, probably a new species, and several specimens of the common West African gadfly (*Tabanus dorsovitta* Walker). A number of one of the Tsetse flies, *Glossina longipalpis* Wiedmann var., *tachinoides*, Westwood, were also taken.

This insect, closely related to the Tsetse fly (*Glossina morsitans*), is called by Dr. Dutton the small Mangrove fly. It is very prevalent up the Gambia river, and comes on board the launches and bites viciously. It is of particular interest, as the case of Trypanosoma Dr. Dutton found in Bathurst was in an Englishman, who was master of the Government launch, living on board, and was frequently bitten by this species of *Glossina*. It is quite possible that this species of *Glossina* acts in the same way as *G. morsitans* in the animal Tsetse disease.

The collection contains no new *Anopheles* but three distinct varities, three new species of *Culex*, and a distinct variety of a previously known one, also a new *Stegomyia* and a *Corethra*. The series of *Anopheles funestus* is most interesting, as it shows very great variation, particularly in the colour of the vein-scales and the position of the cross-veins, which I had found constant before in this species, and which I took to be of some specific value. Great variation is also to be noticed in a large series of *Culex Duttoni* (Theo.) This species is of particular interest, as it serves as one of the intermediate hosts of *Filaria nocturna*. *Culex fatigans* (Wied.) was also found to act as an intermediate host of this *Haematozoon*. In a new banded proboscis species (*Culex anarmostus*) a filaria (sp. incert.) was found in the thoracic muscles. A list of the species, with notes and the descriptions of the *Stegomyia*, *Culex*, and *Corethra*, are here appended, and also a description of the varieties of previously known species.

LIST OF CULICIDAE AND OTHER DIPTERA TAKEN AND BRED BY Dr. DUTTON

A. CULICIDAE.

1. *Anopheles costalis*. Loew.
1a. *Anopheles costalis*. Var. *melas* n.v.
2. *Anopheles pharoensis*. Theobald.
3. *Anopheles funestus*. Giles.
3a. *Anopheles funestus*. Var. *umbrosus* n.v.
3a. *Anopheles funestus*. Var. *subumbrosus* n.v.
4. *Stegomyia fasciata*. Fabricius.
5. *Stegomyia sugens*. Wiedemann.

* The old genus *Anopheles* is now subdivided into several genera; *costalis* comes in Pyretophorus, *pharoensis* in Cellia, and *funestus* in Myzomyia.

6. *Stegomyia albocephala.* N. sp.
7. *Culex [illegible] stigmatosoma.* Theobald.
8. *Culex annulioris.* Theobald. Var. *gambiensis.* n.v.
9. *Culex [illegible].* Theobald.
10. *Culex anarmostus.* N. sp.
11. *Culex thalassius.* N. sp.
12. *Culex tigripes.* Grandpre.
13. *Culex fatigans.* Wiedeman.
14. *Culex euclastus.* N. sp.
15. *Lasioconops poicilipes.* N. sp.
16. *Mansonia uniformis.* Theobald.
17. *Uranotaenia albocephala.* Theobald.
18. *Corethra ceratopogones.* N. sp.

B. PSYCHODIDAE.

Phlebotomus sp. ?

C. TABANIDAE

Tabanus [illegible]. Walker.

D. GLOSSINIDAE

Glossina [illegible]. Wied.)—var. *[illegible]*. Westwood.

CULICIDAE

I. *Anopheles costalis.* Loew

A. gambiensis. Giles

(Ent. Zeit. Berlin, 55 (1866) Loew; Mono. Culicid. I. 157 (1901) Theo. Hand Bk. Gnats, 2nd Edit. Giles, 1902. (=*A. gambiensis.*)

A number of this species from Bathurst, many of them caught in the barracks, prison, and police quarters, Government House; some bred from larvae obtained from a large pool sixteen to eighteen feet in diameter.

The specimens show some variation in regard to the intensity of the costal spots and leg ornamentation. One very marked melanic variety occurs, which is described below. The specimens were taken in October, November, and December. None were found at Baia or McCarthy Island. At Bathurst, Dr. Dutton only obtained *A. costalis* and a few *A. pharoensis.* Theo. This species also occurs at Cape St. Mary, seven miles from Bathurst, where there are a few artificial breeding-places. Colonel Giles has described as a distinct species a specimen of *A. costalis* sent me from Gambia by Dr. Bugnion.

Ia. *Anopheles costalis.* Loew

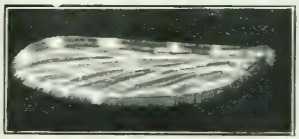
Variety *melas*

Thorax dark brown to almost black, with narrow-curved pale golden scales as in the type; palpi, with *four* pale bands, *very* narrow; the fourth on the apex of the palpi, very scaly at their base; the two apical bands are close together, but quite distinct. Abdomen deep black, with pale hairs, golden at the apex. Legs prominently black, spotted and banded; forelegs with a trace of pale spots on the femora as in the type, pale spots on tibiae, and a narrow band-like spot on the metatarsi, a yellow band involving both sides of the joints at the metatarsus and first tarsal, and at the first tarsal and second tarsal; in the mid-legs the tibiae are spotted, but the tarsal banding is not distinct, nor are the tarsi banded in the hind legs, and the tibiae and femora spots are not so well defined.

WINGS OF GAMBIAN *CULICIDAE*

1

6



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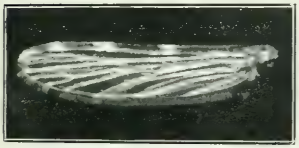

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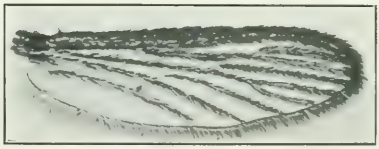

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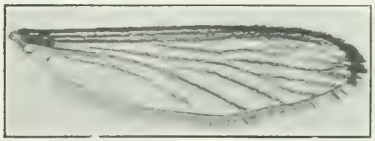

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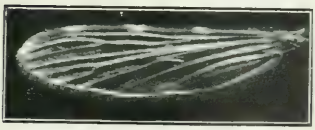

5

10

1. *Anopheles funestus.* Giles. ♀ var.
2. *Anopheles funestus.* ♀ Typical.
3. *Anopheles funestus.* ♂
4. *Anopheles funestus.* Var. *anisochloros.*
5. *Anopheles rhodesiensis.* Theo. ♀
6. *Anopheles pharoensis.* Theo. ♀
7. *Anopheles* [illegible]. Low. ♀
8. *Culex thalassius.* N. sp.
9. *Culex* [illegible]. N. sp.
10. *Anopheles* [illegible]. Theo. ♂

(All nine times exact No. 1 which is twelve).

a *b*

FIG. 1

Anopheles funestus. GILES

a. Head of ♂ ; *b*. Head of ♀

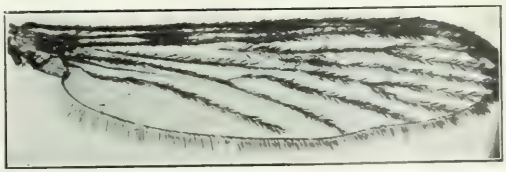

FIG. 2

Wing of ♀ *A. rufus* to show [illegible] markings.

× 18

Wings with black- and yellow-scaled areas, the former predominating ; the costa is deep black, the second spot only appearing on the costa as a small, almost white, spot ; there are also two small pale spots on the costa towards the base of the wing ; on the first long vein are six pale spots, one under the white costal spot, the other arranged much as in the type, but the black areas are pronounced ; the greater part of the third long vein is pale and the second mostly dark scaled, except for the pale patch at the base of the fork and a pale patch towards the apex of its lower branch ; most of the fourth dark scaled, the lower branch of the fork having two pale patches. The fifth mostly pale scaled, but with three dark patches on the upper branch and a small one at the apex and another at the base of the lower and its stem ; sixth with three black spots ; fringe spots very indistinct. Fork-cells and cross-veins as in the type.

Length—5 mm. *Habitat*—Gambia (Dutton). *Time of capture*—December.

Observations—Described from a single female in perfect condition. It forms a very distinct melanic variety. The chief difference from a typical *A. costalis* is the absence of pale costal spots, one only reaching the actual costa, except at the base ; the whole wing field is darker, and the legs with more pronounced spotting. The markings in the first long vein are, however, typical of the species.

II. *Anopheles pharoensis*. Theobald

(*Mono. Culicid.* I, 169 (1901). Theobald)

Nine specimens (seven ♀'s and two ♂'s) of this beautiful *Anopheles* from the following localities : the barracks and prison, Bathurst, and on a marsh at the back of the town, McCarthy Island. A specimen was also hatched from a larva taken in a pool, fifteen yards across, at Box Bar. The specimens show considerable variation in size, one only measuring 5 mm. ; there is also marked variation in colour, due evidently to some containing blood. One large pool alone, some way from the town of Bathurst, acted as a breeding ground of this species. This large *Anopheles* also occurrs at Cairo, Central Africa, and in Palestine, and probably occurs all over Africa and in other parts of Asia.

III. *Anopheles funestus*. Giles

(*Mem. II, Liv. School of Trop. Med.* p. 50 (1900), Giles ; *Mono. Culicid.* I, p. 182 (1901), Theobald)

A large series of ♂'s and ♀'s of this species were taken in the following places :—Baia, the Cape, and McCarthy Island. The species occurs in native huts, and many were taken on the walls in the prison and in Government House at McCarthy Island. They were mostly taken in December. Both at Baia and McCarthy Island there were no ordinary or artificial breeding-grounds about, except here and there a large marsh. At Baia the marsh was about two miles away from the town. At Cape St. Mary, seven miles from Bathurst, this small *Anopheles* occurs in numbers, and the larvae are here found in rice swamps. This species, to some extent, resembles *A. rhodesiensis*, but can at once be told from it by the pale fringe spots and by the pale scaled areas to the wings, and the more pronounced dark patches. The white palpal bands are also, it seems, wider apart in *A. rhodesiensis*. Several of the specimens of *A. funestus* in this collection present well-marked deviations from the type. Speaking generally, the pale and dark scaled areas on the veins are not so pronounced, and the base of the fork-cells have not quite the same relative positions. In my monograph (Vol. I, p. 186) I pointed out that one of the characters separating *Funestus* from the larger *Rhodesiensis*, was the position of the cross-veins, this does not hold good, for in the *Funestus* from Gambia I find the cross-veins in some like *Funestus* as I described, in others like *Rhodesiensis*. The supernumerary and mid may be either in one line as the mid may be in advance of the supernumerary and posterior. *Rhodesiensis* has, however, *all* the vein scales dark, and the fringe unspotted, and the third long vein always dark. The wings are *always* black at the base of the costa, whereas, in most *Funestus* there is a pale costal spot near the base. *Funestus* is also smaller than *Rhodesiensis* ; the latter has so far only been sent from Mashonaland.

IIIa. *A. tunestus.* Giles

Var. *Umbrosus.* Theo.

Costa black at the base, unbroken by the typical small pale spot. Veins with the dusky scales predominating ; the pale scaled areas restricted to the region of the cross-veins and base of the fork-cells and on the fifth long vein ; *the third long vein dark as in Rhodesiensis.* Wing fringe spotted as in the type, but not so prominently.

IIIb. *A. tunestus.* Giles

Var. *Subumbrosus.* Theo.

Costa black at the base, unbroken by any pale spot. Dusky scales predominating, but not contrasted as in the type with the pale scaled areas. *Third long vein pale-scaled in the middle,* and pale scaled areas also on the fourth, fifth, and sixth.

IV. *Stegomyia fasciata*

(*Syst. Antl.* 36, 13, 1895. *Mono. Culic.* I, 289, 1901. Theo.)

This species is evidently common in Gambia, specimens showing great variation in size were taken in Bathurst in numbers: some in native huts, and also in European dwellings. Many seem to have been hatched out from larvae taken in a tub of well water, and others from a canoe. This species was taken in October, November, and December, and was observed feeding, as recorded elsewhere,* during the daytime (4 p.m.)

V. *Stegomyia sugens.* (Wied.)

Aus. Zweiflig Ins. 545 (1828) Wied ; *Mono. Culic.* 300 (1901) Theo.

Three ♂'s and two ♀'s taken near Bathurst. This *Stegomyia* can easily be told by the spots on the mesonotum and the pale band on the femora near the apex. Hatched out from larvae taken in ground-nut gutters during November.

VI. *Stegomyia albocephala.* N. sp.

Head covered with flat dull white scales, a small dusky patch on each side and a posterior semi-circular area of dark upright forked scales.

Thorax deep rich brown covered with scattered golden scales, showing more or less two dark eyes like spots ; scutellum with small flat white scales. Abdomen black with narrow basal white bands. Legs black, the hind tibiae with a marked apical white band.

♀. Head brown, covered with dull white flat scales, with a silvery sheen, a small patch of black scales on the border about the middle of the eyes, and dull black scales at the sides, posteriorly are black upright forked scales, giving the head a dark appearance of semicircular form, in front the upright forked scales are yellow. Proboscis, palpi, and antennae deep blackish-brown ; palpi with a trace of a pale band on its basal half, two apical joints nearly equal, with black hair-tufts and also black hairs at the apex of the anti-penultimate joint.

Thorax rich deep-brown with scattered golden narrow-curved scales, and showing in certain lights two dark eye-like patches on the ground surface ; scutellum covered with small flat shiny creamy-white scales ; pleurae brown with patches of grey scales ; metanotum deep clear brown.

Abdomen black with basal white bands which spread out laterally ; venter black with broad basal white bands ; densely clothed with long brown hairs.

Legs black, unbanded, except for a clear, rather broad, white apical band to the hind tibiae. Coxae brown, bases and venter of the femora grey, ungues of the fore and mid legs unequal, the larger uniserrated, the smaller (?) hind ungues rather long, curved, equal, and simple. Wings with the first submarginal

* *Mon. Culicidae*, Vol. 1, p. 62. Theobald. (1901).

cell longer and narrower than the second posterior cell, its base nearer the base of the wing than that of the latter, its stem not quite so long as the cell ; stem of the second posterior as long as the cell ; posterior cross-vein about half its own length distant from the mid cross-vein ; halteres with yellow stem and slightly fuscous knob.

Length 4·5 mm. *Habitat.*—Gambia. *Time of appearance.*—November.

Observations—Described from a single perfect male, bred by Dr. Dutton from a larva found in a canoe. This *Stegomyia* very closely resembles *Culex univittatus* mihi, and might readily be mistaken for it, on account of the conspicuous hind tibial banding, but an examination of the head and scutellum reveals flat scales only. The pale head and white shiny scutellum with the brown thorax form also striking characters.

VII. *Culex bivittipalpis*. Theobald

(*Mono. Culicid.*, Vol. i, p. 378 (1901). Theobald)

A series of this species, which I described from some specimens from Mashonaland, were hatched out by Dr. Dutton from larvae taken in the water of ground-nut insect traps, *i.e.*, gutters full of water around the ground-nuts. Other specimens were hatched from a small dug-out pool in a rice swamp. The specimens hatched out in November and December.

The abdomen in the ♂ is much better marked than in the original type. A fresh description of the male is therefore appended.

♂. Palpi black, with four white bands, the two apical ones on the base of the last two joints narrow ; last two joints with dense tufts of hair, hairs black, except at the apex, where they are pallid ; the antipenultimate joint is also hairy down to near the first white band ; antennae banded black and grey, with deep-brown plume-hairs ; proboscis with a narrow white band.

Thorax as in ♀. Abdomen black, the second to the fifth segments with basal white bands, the sixth and seventh have the basal band spreading down each side, the last segment with a basal median white spot ; apical hairs golden ; there are also white lateral linear prolongations of the basal bands to each segment ; venter covered with pale creamy yellow scales ; legs much as in the ♀ ; fore and mid ungues unequal, both uniserrated.

Wings paler than in the ♀ ; first submarginal cell longer and narrower than the second posterior cell, the bases of the fork-cells nearly level ; stem of the first submarginal rather more than half the length of the cell ; stem of the second posterior as long as the cell ; posterior cross-vein about its own length distant from the mid cross-vein. Halteres pale, but the knob slightly tinged.

Note.—Fresh specimens are much darker than old ones. The proboscis band is narrower in the male than in the female.

VIII. *Culex annulioris*. Theobald

Var. *Gambiensis. n.v.*

(*Mono. Culicid.*, Vol. i, p. 371)

Proboscis with white band. Thorax brown with narrow-curved pale brown and grey scales on the front two-thirds ; narrow-curved black ones on the hinder third of the mesonotum ; the pale brown scales in front form more or less a distinct median line, with a narrow pale scaled line on each side and an indistinct darker broad line on each side of the narrow pale line, bounded laterally by mostly pale scales ; the scutellum, as in the type, with small black scales at the base of the mid-lobe and grey ones on the apical portion ; metanotum bright amber brown. The abdomen is like the type, but the triangular basal white spots are very indistinct, but can be detected on each segment by a few white scales when examined under the microscope.

The band on the proboscis is not quite so broad as in the type, and the stem of the first submarginal cell is very nearly half the length of the cell.

Length —5·5 mm. *Habitat*—Gambia (Dutton). *Time of capture*—January.

Observations—Described from a single female hatched from a larva taken in water in a rice field.

It resembles the type except in regard to the colour of the thoracic scales, the thorax is characteristically ornamented, under a lens the first part (two-thirds) looks ashy grey, but more or less ornamentation, as described, may be seen on careful examination, the paler anterior area is clearly marked off from the dark scaled posterior third. It is undoubtedly only a variety of the species I described as *C. annulioris*, from Salisbury, Mashonaland.

In the structural figure of this species in the *Monograph of Culicidae*, fig. 127, p. 372, vol. I, I figured the palpi as three-jointed, the apical joint being characteristically swollen and truncated, this is really the penultimate joint, the apical joint was missing, I find the apical joint is long and thick.

IX. *Culex duttoni*. Theobald

Mono. Culicid. II, p. 318 (1901). Theo.

A large series of this mosquito were taken at McCarthy Island and Bathurst Some were hatched out from larvae taken in a canoe on the foreshore, others from a tub of well water during October, November, December, and January. This is evidently a common West African insect along the coast; I have not at present seen any from inland. It was found to be one of the hosts of *Filaria nocturna* by Dr. Dutton.

This species is subject to considerable variation, both in size and in thoracic ornamentation. In some specimens brought back by Dr. Dutton the thorax shows no ornamentation at all, others have the thorax adorned as I described in the *Monograph of the Culicidae*.

X. *Culex anarmostus*. N. sp.

Thorax dark brown to brown, with two darker median parallel lines on the denuded surface, covered with pale, dull golden, narrow-curved scales, showing faint longitudinal arrangement. Proboscis with a pale creamy band. Abdomen brown, with curved basal white bands. Legs brown, with faint apical and basal pale banding. Ungues equal and simple.

♀. Head brown, with narrow-curved, pale, creamy-grey scales, brown upright forked ones and small flat white ones at the sides, and whitish curved ones round the eyes. Proboscis brown, with a median pale band very distinct beneath; palpi black, with a few white scales; clypeus black; antennae dark brown, basal joint testaceous. Thorax brown to almost black, covered with narrow golden curved scales somewhat paler behind, to some extent arranged longitudinally; scutellum pale brown, with pale narrow-curved scales; metanotum deep brown; pleurae pale brown and cinerous, with a few patches of grey scales.

Abdomen deep brown, with curved white to creamy basal bands; first segment nude, save for two median patches of black scales; border-bristles pale; venter white, with narrow apical border of brown scales.

Legs brown; femora pale ventrally, apex of tibiae white, base and apex of metatarsi and first two tarsals pale banded, also a white knee spot on the hind legs; femora and tibiae bristly; ungues equal and simple; hind tibiae about the same length as the hind metatarsi. Wings with brown scales, those on the third and fifth being the darkest; first submarginal cell longer and a little narrower than the second posterior cell, its base a little nearer the base of the wing than that of the latter, its stem half the length of the cell; stem of the second posterior about two-third the length of the cell; posterior cross-vein about its own length distant from the mid cross-vein. *The medium vein scales of the third, fifth*, and to some extent the lower branch of the second fork-cell, rather larger than in most *Culex*, and very dark. Halteres pale.

Length—4·5 mm.

Habitat—Freetown, Sierra Leone (Austen), Gambia (Dutton).

Time of capture—September (Freetown, Austen; Gambia (in November), Dutton.

Observations—Described from a single female from Freetown; bred from water in a drain by Mr. Austen.

A specimen sent me by Dr. Dutton, from Gambia, is evidently this species, but it is rather too damaged to say definitely. Dr. Dutton found a filarial embryo in the thoracic muscles.

XI. *Culex thalassius*. N. sp.

Proboscis with a narrow median white band. Thorax dark-brown, with narrow deep golden-brown curved scales. Abdomen dark brownish-black, with narrow basal grey bands, often absent; penultimate segment with lateral white spots only; pleurae very pale grey. Legs deep brown, with faint pale bands to some of the mid and fore tarsi; apices of tibiae pale, hind legs unbanded. Bases of the fork-cells nearly level.

♀. Head deep brown, with narrow-curved, pale greyish scales and black upright forked ones; palpi black; proboscis black, with a narrow distinct pale band; antennae brown; clypeus black.

Thorax deep brown, with narrow rich brown curved scales; scutellum brown, with narrow golden-brown curved scales, and deep brown border-bristles; pleurae very pale and shiny grey; metanotum deep brown. Abdomen black, with narrow basal white bands, or unbanded with traces of basal white lateral spots, venter dark, with broad basal grey bands.

Legs black, bases pallid, also venter of femora, apex of femora, and to some extent the tibia, pale; tarsi and metatarsi with *narrow* pale basal bands, indistinct on the last two tarsi; hind metatarsi and tibiae of about equal length.

Wings with the veins with brown scales; fork-cells rather short, their bases about level; the first submarginal a little longer and narrower than the second posterior, its stem a little more than half the length of the cell; stem of the second posterior about two-thirds the length of the cell; posterior cross-vein nearly twice its own length distant from the mid.

Length—4·5 mm. *Habitat*—Gambia. *Time of capture*—October and November.

Observations—Described from a series taken and bred by Dr. Dutton. The larvae were mostly taken in a drain of tidal water, and others from a pool in a mangrove swamp; others from a canoe on the foreshore, and some from a pool of tidal water that had soaked through sand into a drain.

The species is very variable; some show distinct abdominal banding, others none at all. It somewhat resembles *C. duttoni*, but is smaller, more fragile, and the legs have only faint basal banding, and the fork-cells are slightly different.

This species and *C. duttoni* come very close together, but they are certainly distinct.

XII. *Culex [illegible]*. Grandpré

(*Les Moustiques*. [1921.] Grandpré. *Mem. Cinchona*, II, p. 34. (1924.) The Bald)

A series of ten ♂'s and ♀'s taken at Bathurst and McCarthy Island during October. Some specimens were taken on the sides of a discarded well; the majority were hatched from larvae taken in canoes, and also from a pool.

This large spotted-legged *Culex*, with its apical pale abdominal bands, seems to be generally distributed over Africa, but so far has not been recorded further south than Natal, as well as occurring in Mauritius and Australia. It is the species that Dr. Bancroft calls the 'long-lived mosquito.' Some of the specimens are very small, not more than 5·5 to 6 mm., others are as much as 7 mm.

XIII. *Culex fatigans*. Wied.

This common household *Culex* occurs in abundance in Bathurst, and was taken in numbers as usual indoors. Some were hatched from larvae 'from an old tin,' others 'from a well,' 'from a rain tub,' 'from water in rice field at Cape St. Mary,' 'from well in Government House with heaps of green slime.' This species seems abundant in the prison at Bathurst, and has been shown by Dr. Dutton to be the intermediate host of *Filaria nocturna*, as well as *Culex duttoni*.

They were taken in October, November, December, and January.

XIV. *Culex euclastus*. N. sp.

Head brown with grey scales, most distinct around the eyes. Thorax brown with tawny-brown scales. Abdomen brown, unbanded, with basal white lateral spots, which show dorsally on the last few segments; legs brown, unbanded, basally grey. Sixth long vein rather close to the fifth.

♀. Head dark brown with narrow-curved dull-grey scales, rather wider and paler around the eyes, and with dark upright forked-scales; proboscis and palpi dark brown: antennae dark brown, basal joint paler. Thorax brown with very small narrow-curved scales of a fawny-brown to dull brownish-grey hue, and with dark-brown bristles; scutellum paler brown with narrow-curved grey scales; metanotum brown; pleurae pallid.

Abdomen brown, unbanded, with basal white lateral spots, which are pronounced, and which show dorsally on the last few segments. Venter, brown with dull grey basal bands; border-bristles and hairs brown, except at the apex, where they are pallid; the denuded surface of the abdomen has a shiny and somewhat pale steel colour.

Legs brown, unbanded, a faint pale knee spot on the hind legs and traces of a pale apical tibial spot; bases of the legs and centre of the femora pallid; hind metatarsi about the same length as the hind tibiae; legs with a few bristles. Ungues small, equal and simple. Wings with deep-brown scales, costa very dark; first submarginal cell longer and narrower than the second posterior cell, its base very slightly nearer the base of the wing than that of the second posterior cell; its stem rather less than half the length of the cell; stem of the second posterior rather more than two-thirds the length of the cell; posterior cross-vein longer than the mid, rather more than its own length distant from it; the sixth long vein runs parallel with the fifth at its base, and is rather closer than usual to it. Halteres brown, with dense white scales.

Length 4 mm. *Habitat*—Gambia. *Time of capture*—October.

Observations—Described from two perfect ♀'s bred by Dr. Dutton from larvae taken from pools at Box Bar.

It is a very small fragile-looking species, unlike any other I have seen from Africa, and to some extent approaches *Culex nigritulus* Zett, but is very distinct in regard to thoracic scale structure and venation. The type is deposited in the British Museum (Nat. Hist.) Collection.

Genus *Lasioconops*. New. gen.

Head clothed with similar scales to *Culex*; antennae with the basal joint with a few scales; palpi short in both sexes. Thorax clothed with narrow-curved scales. Abdomen clothed with flat scales and with *large projecting flat lateral scales, with deeply dentate apices*, in more or less tufts. Wings with typical *Culex* scales and venation.

This genus is separated from *Culex* on account of the peculiar and characteristic lateral scales on the abdomen, which give the insect a ragged appearance.

A single species only at present occurs, *L. poicilipes* from West Africa. The ♂ is unknown.

XV. *Lasiomyia pallipes*. N. sp.

Anterior half of thorax with ashy grey scales and chestnut brown ones, the former towards the edge of the pale area, posterior part of the thorax dark brown with brown scales. Abdomen black, with basal white bands. Proboscis brown, with a pale median band. Legs deep brown, the femora mottled with creamy scales, the tibiae with a row of pale spots, metatarsi and tarsi with narrow basal pale bands, which to some extent involve the apices of the preceding segments.

♀. Head dark brown, with narrow-curved pale grey scales, brown and ochraceous forked scales and small flat grey ones at the sides; antennae brown, basal joint black on the inside, with small white scales, and with a grey sheen on the outside, second joint bright testaceous; palpi black scaled, with apical grey scales; proboscis black scaled, with a pale median band; clypeus deep brown, with frosty sheen.

Thorax black, the anterior two-thirds clothed with narrow-curved grey scales, palest at the posterior edge of this pale scaled area, where they form a wavy line; posterior portion of the mesonotum with narrow-curved black and brown scales and numerous black bristles. Scutellum brown, with narrow curved dull creamy scales, and with eight black border-bristles to the mid lobe; pleurae black, with patches of white scales and pale creamy hairs.

Abdomen black, with narrow basal bands of white scales and very large and peculiar white and ochraceous lateral projecting scales; posterior border-bristles golden, short; venter black, with white scales. Legs dark brown, the femora spotted and mottled with pale scales, the tibiae with small creamy spots; metatarsi and tarsi dark brown, with narrow pale ochraceous bands involving both sides of the joints.

Wings with typical brown *Culex* scales; surface of the wing with minute bristles; first submarginal cell longer and narrower than the second posterior cell, its base nearer the base of the wing than that of the latter, its stem about one-fourth the length of the cell; stem of the second posterior not quite one-third the length of the cell.

Supernumerary cross-vein not level with the mid cross-vein, a little nearer the base of the wing; posterior cross-vein about two-and-a-half times its own length from the mid cross-vein; sixth vein rather densely scaled. Halteres dusky ochre.

Length—6 mm. *Habitat*—Bonny, West Africa (Annett), and Gambia (Dutton). *Time of capture*—July (Annett), December (Dutton).

Observations—Described from a single ♀, somewhat denuded but easily told from all other Culicidae by the curious abdominal lateral scales, which are certainly of generic importance. The spotted legs give it some resemblance to *Culex tigripes*, but the banded tarsi and proboscis and general ornamentation will at once separate it.

XVI. *Mansonia uniformis*. Theobald

Mansonia africana. Theobald

(*Mono. Culicid.* II, p. 180 (*Uniformis*) and p. 187 (*Africanus*) (1901) Theo.)

The collection contains ten specimens of this abundant African *Mansonia*. They were taken at McCarthy Island, in the marsh at the back of the town, and were noticed to bite very viciously. A single specimen was also taken in the prison at Bathurst, in October, the others were taken in December. Dr. Daniels has shown this *Mansonia* to be an intermediate host of the *Filaria*.

After carefully comparing a fresh series of South Indian and Ceylon *Mansonia* with the ones I described as *M. africanus* (*Mono. Culicid.* II, p. 187), I am convinced they are the same as the Indian *M. uniformis*. *M. africanus* must, therefore, sink as a synonym of *M. uniformis*. The thoracic ornamentation very soon becomes destroyed, and the thorax has then a non-ornamented or uniform appearance.

XVII. *Uranotænia cæruleocephala.* Theobald
(*Mono. Culicid.* II., p. 256, 1901

I have described the ♀ of this species but not the ♂, a description of which is here given :

♂. Thorax like the female, but the metallic patches in front and the lines in front of the wings very pale blue in certain lights. The head is brown and deep violet in the middle, with pale blue scales on each side ; palpi brown, proboscis brown, swollen at the apex ; antennae banded brown and deep brown, densely brown plumed. Abdomen showing a pale apical ventral spot on the fifth segment ; paler ventrally than dorsally ; fore ungues unequal, the larger sickle-shaped simple ; mid and hind apparently equal and simple, irregularly curved. Wings with brown veins, a line of metallic flat pale blue and violet scales at the base of the costa and another at the base of the fifth long vein, posterior cross-vein twice its own length distant from the mid cross-vein ; halteres with pale stem and brown knob.

Length—3 to 3·5 mm. *Habitat*—Gambia (Burdett ♀) and (Dutton ♂). *Time of capture*—December.

Observations—The ♂ is described from two fairly perfect specimens caught in a marsh behind the town on McCarthy Island. I feel certain from the thoracic ornamentation it is the male of *U. cæruleocephala* (mihi) described from Bonny. The chief difference from the female lies in the head being deep violet in the middle, instead of pale blue all over. The markedly bright brown thorax with the metallic white and pale blue ornamentation should at once separate it. I had to mount some of the legs of the ♂ type in balsam to make anything of the ungues. In doing so I misplaced them, so am not sure if the anterior or mid ungues are unequal.

XVIII. *Corethra ceratopogones.* N. sp.

♀. Thorax pale brown to fawn with darker brown markings ; metanotum pale chestnut-brown ; pleurae pale fawn and cinerous ; head brown, proboscis and palpi brown, with numerous rather long brown hairs ; antennae banded brown and grey. Abdomen very pale fawn to cinerous, with narrow dark brown apical borders to the segments, and dark brown at the sides, only partly, however, on the last two apical segments ; abdomen hairy ; apex dark brown ; lamellae brown.

Legs multibanded, with brown and frosty grey on the femora and tibiae ; fore femora with six dark bands and also the fore tibiae, apex and the basal band of both, pale ; metatarsus and first three tarsi banded with dark brown in the middle, apical joint pale, ungues very small, simple, and equal ; mid femora with eight dark bands, tibiae with six, the tarsal are broadest, base and apex of both joints pale ; metatarsi and tarsi with very broad dark median bands ; ungues small, equal, and simple ; hind femora with eight, and hind tibiae with seven dark bands, base and apex of each pale, metatarsus with two median dark bands, tarsi with a single median dark band. Ungues small, equal, and simple. Wings densely clothed with long brown hair-like scales, with three dusky patches on the costa, the median one where the sub-costal joins the costa spreading on to it, the apical one spreading on to the first long vein, the basal one rather indistinct, the median spread across the wing-field as a faint dusky band ; the third long vein is faintly darker than the rest. Wing fringe long and dense ; first submarginal cell considerably longer and narrower than the second posterior cell, its base very slightly nearer the base of the wing than that of the second posterior cell ; its stem about one-fourth the length of the cell, not quite so long as the stem of the second posterior cell ; stem of the latter less than half of the cell ; the second long vein carried a long way past the marginal cross-vein ; supernumerary and mid cross-veins sloping towards the apex of the wing ; posterior and mid cross-veins in one line. Halteres pale.

Length 2·5 mm. *Habitat*—Gambia (Dr. Dutton). *Time of capture*—December.

Observations—Described from a single ♀ taken by Dr. Dutton on the side of a tub on McCarthy Island. It is the only African *Corethra* known, and can easily be told by the wing ornamentation and

leg banding. The specimen is described partly from a xylol-balsam preparation. The mouth is provided with very distinct piercing lancets. It comes most near *Corethra brasiliensis*, but can at once be separated by the leg banding, wing venation, and spotting.

The great extension of the second long vein past the marginal transverse vein is a very marked character.

OTHER DIPTERA

Phlebotomus. Sp. ?

Several specimens of a large 'owl-midge' hatched out from pupae, taken in November and December from a duck pond. The species is probably new. It seems to be common in West Africa.

Tabanus dorsovitta. WALKER

Two specimens of this common West African gadfly, which bites severely, taken in mangrove swamps and called by Dr. DUTTON the large Mangrove fly.

Glossina longipalpis. WIEDEMANN
Var. *tachinoides.* WESTWOOD

Eight of this Tsetse fly were taken by Dr. DUTTON in November. It bites viciously along the river. It is closely related to the *Glossina longipalpis*, WIED., but constitutes a distinct variety. It was described by WESTWOOD as a distinct species. Mr. AUSTEN treats it as a variety of the type. Its possible connexion with the *Trypanosoma* in man has been referred to before.

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MEMOIR I

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FIRST REPORT OF THE TRYPANOSOMIASIS EXPEDITION TO SENEGAMBIA

FIRST REPORT

OF THE

TRYPANOSOMIASIS EXPEDITION TO SENEGAMBIA

(1902)

OF THE

LIVERPOOL SCHOOL OF TROPICAL MEDICINE
AND MEDICAL PARASITOLOGY

BY

J. EVERETT DUTTON, M.B., B.Ch., Vict.
WALTER MYERS FELLOW, THE UNIVERSITY, LIVERPOOL

AND

JOHN L. TODD, B.A., M.D., C.M., McGill

WITH NOTES BY H. E. ANNETT, M.D., D.P.H.
AND AN
APPENDIX BY F. V. THEOBALD, M.A.

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PREFACE

IN 1901, one of us (DUTTON) saw trypanosomes in the blood of a European who was suffering from an illness characterized by a peculiar combination of symptoms.[15, 16]

The clinical picture presented was one which might be confounded with a *tropical cachexia*. In addition, the trypanosomes were rarely present in the finger blood, and were never very numerous. The discovery of parasites in this case made it necessary to enquire whether their occurrence was merely a curious pathological coincidence or specific. If the latter were assumed to be the case, it at once became probable that some tropical illnesses which had previously remained unclassified, or had been wrongly diagnosed, would be found to be cases of trypanosomiasis.

Before the details of study of this case were published in the *Thompson Yates Laboratories Report*, May, 1902, a trypanosome was found in a blood film taken from a native child in the Gambia ; and the discovery of a second case of human trypanosomiasis made it probable that the first was not altogether a curiosity.[16] The rarity with which the parasites appeared in the peripheral circulation of the European case, and their fewness when they were present, fully explained how easily they might escape detection and permit the malady in which they occurred to remain unidentified.

The Committee of the Liverpool School of Tropical Medicine realized the possible importance of this new parasite as a cause of disease and sent this Expedition to Senegambia to make further investigations on the subject.

While the members of the Expedition were in Gambia, the first European case remained in Liverpool under the care of Dr. H. E. ANNETT, who recorded observations on the course of the disease, and experimented with the parasite. The results of his work are incorporated in this report.

Our thanks are due to Professor HERDMAN, Mr. H. C. ROBINSON, and Mr. J. JOHNSTONE for identifying some species of birds, bush rats, and frogs.

We give a list of references to various articles on trypanosomiasis which may be useful to those interested in the subject.

The Communication[4] written by Professors BOYCE, ROSS, and SHERRINGTON, has spared us the task of discussing the history of the discovery of human trypanosomiasis. To them, who so clearly defined our situation, and to all, both in England and in Africa, who have aided us in our work, we are most grateful.

Our thanks are particularly due to Dr. ANNETT for the constant kindness with which he has met our many trespasses on his time, and to Dr. H. WOLFERSTAN THOMAS and Dr. S. F. LINTON, for their goodness in correcting the proofs.

J. E. D.
J. L. T.

4th September, 1903

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FIRST REPORT OF THE TRYPANOSOMIASIS EXPEDITION TO SENEGAMBIA (1902)

I. INTRODUCTION

WE arrived in Bathurst on the 2nd of September, 1902, and remained there for three weeks. Cape St. Mary, seven miles from Bathurst, then became our headquarters, and we stayed there until the first week in January, when we went to McCarthy Island, which we made our base until we left for Senegal on the 7th of May. Subsequently, we remained in French territory until we left for England about the middle of June, 1903. While we were in the Gambia we arranged our movements so as to allow the study of the distribution and of the properties of the Gambian trypanosome to proceed simultaneously. To this end we established our laboratory at a convenient spot, as a base at which experimental work could be carried on, and from which short journeys could be made with the object of determining the frequency of trypanosomiasis among the natives.

Our stay in Senegal was almost totally occupied in studying the sanitary conditions of the principal towns, and in drawing up a scheme, at the request of M. Roume, the Governor-General of French West Africa, on which to base an anti-mosquito campaign.

A description of the work done in Senegal has been embodied in another report. This, 'The First Report' of our expedition, is intended to describe only a very small portion of the work done in the Gambia on trypanosomiasis.

Although trypanosomes were found in men, horses, rats, mice, birds, snakes, tortoises, and frogs, we were able to study only those parasites found in men and horses. The distribution, clinical symptoms, and the morphology of these latter parasites, together with a synopsis of their reactions in experimental animals, will be first described; there will then follow a brief description of the organisms seen in the remaining hosts.

We shall only briefly mention our unsuccessful attempts to transmit the disease from infected to uninfected animals by means of biting flies.

A second report will contain a more extended study of the results of animal inoculations of the various trypanosomata found in the Gambia. It will also contain our, at present incomplete, observations on their agglutinative powers and on the

possibility of altering their virulencies. We reserve for this report descriptions of the microscopical *post-mortem* appearances in infected animals, and a detailed comparative examination of all known pathogenic trypanosomes.

Laboratory Methods

Blood was examined, both fresh and stained. When it was possible the centrifuge was used in preparing the fresh specimens, which were examined as soon as prepared. We found that if trypanosome-infected blood were mixed with equal parts of the following solution and centrifuged, the great majority of the parasites were collected with the white cells in a thin white layer, which could be easily removed with a fine pipette :—

Sodium citrate .	1 gramme.
Normal saline solution	100 c.c.

For centrifuging the blood of animals from which it was possible to obtain several cubic centimetres, urine centrifuging tubes were used. These were far too large, however, for examining the blood of natives, small birds, and animals, of which we could obtain only a few drops at a time. For examining such small quantities, varying in amount from 0·1 c.c. to 0·25 c.c., we adopted the following method. Rather thin-walled, easily fusible glass tubing, having an internal diameter of five mm., was drawn out into bulb-shaped capsules having an arm at either end, and capable of being placed in the haematokrit arm of a centrifuge.* Blood was allowed to enter the bulb by capillarity, until it was half or three-quarters filled. The sodium citrate solution used as a diluting fluid was then allowed to fill up the remaining space, and the bulb, its longer arm having being carefully sealed in the flame of a spirit lamp, was placed in the centrifuge.

In fifteen minutes a well-marked white ring is present. The serum and diluting fluid can very quickly be removed by gently scratching and then breaking the glass about four or five mm. above the ring, and smartly tapping the bulb containing the undesired clear fluid. The white ring can then be easily removed by a capillary pipette and examined under a coverslip as a moist preparation.

We nearly always used a one-sixth (Zeiss D) objective with a No. 4 ocular (the diaphragm of which had been removed) in searching fresh blood for trypanosomes. By doing this we secured a large field, and were able to examine slides very quickly. Since a living parasite is always 'spotted' by its movements rather than its form, we lost but little efficiency in so doing. Even with the aid of this manoeuvre, ten to fifteen minutes were required to examine the amount of blood covered by a three-quarter inch square coverslip, the size which we used throughout our work.

Blood films on slides were taken from every case for permanent preparations and further study.

* [illegible] *Proceedings*, Vol. LXX, No. 464, 1902; Dutton, *The Laboratories Report*, Vol. IV, pt. ii, 1902.

Films were fixed either by absolute alcohol or by the vapour of the following mixture, in which preparations were allowed to remain for from five to fifteen seconds, as recommended by PLIMMER and BRADFORD.*

Two per cent. solution Osmic Acid
Glacial Acetic Acid - - - } Equal parts.

We found the latter to be the better fixative. Its results were more constant, and the minute structure of the parasites, particularly the chromatic granules, were better preserved.

All blood films, except where it is otherwise stated, were stained by the following modification of ROMANOWSKY's stain, suggested by Dr. MACCONKEY :—

Solution A. Medicinal methylene blue (Hoechst) - - 0·5 gramme
Sat. solution of chemically pure borax in distilled water - - - - - - 50·0 c.c.
Incubate for four days at 37°C., then add absolute alcohol - - - - - - 50·0 c.c.
and allow to stand for one day before using.

Solution B. Eosin, extra B.A. crystal (Hoechst) - - 0·25 gramme
Distilled water - - - - - 50·00 c.c.
Absolute alcohol - - - - - 50·00 c.c.

These are the stock solutions. For laboratory use dilute each with distilled water, one part of stain to nineteen of water. Support the slide to be stained face downwards. Mix equal parts of the diluted stains in a small flask and pour immediately into the staining dish. The length of time necessary for staining varies from three to six minutes.

When staining is complete, wash the specimen quickly but thoroughly in water and allow it to dry in the open air.

The quantitative estimations of blood cells were made with the THOMA-ZEISS 'blood counting apparatus.' A Zappert ruled cell was used, and both erythrocytes and leucocytes were estimated from the same preparation. The haemoglobin was estimated with a FLEISCHEL's haemoglobinometer.

The qualitative leucocyte counts were made almost wholly from slides stained by the above-mentioned modification of ROMANOWSKY's method. When it was considered necessary to corroborate the results obtained by these methods, slides fixed by heat and coloured with EHRLICH's tri-acid mixture were also examined.

In order that our tables of differential leucocyte counts may convey a real meaning we have thought it well to define as exactly as possible what are the characteristics which have determined the headings under which we have classified the leucocytes. Cells having one of the three recognized types of granulation, as described

* Plimmer and Bradford, *Quart. jour. mic. science*, Vol. XLV, part iii.

by Ehrlich* present no difficulty. It is in the estimation of the non-granular, mononuclear elements that there is a lack of uniformity. The criteria by which various observers decide exactly to what class a doubtful cell belongs are not always the same.

Although there are two, or perhaps three, well-marked 'types' of mononuclear leucocytes, forms intermediate between them may occur. There is no definite characteristic by which such intermediate forms may be classified; and in differential counts, as often presented, the personal equation is a regrettable factor. It is in an effort to avoid this personal error, and to present our work in a form which will have a real clinical value, that we have grouped our mononuclear elements in the manner here described.

The deeply basophile lymphocyte of about the same size as a red cell, with deeply staining cytoplasm and central, relatively large, nucleus is a constant, easily recognizable type. It must be remembered that, though forms are often seen whose protoplasm is not more basophile than their nuclei, yet these cells possess every other characteristic of small lymphocytes, and as such they must be classified. A study of a sufficient number of films will lead from these small forms, by insensible gradations, through a long series of mononuclear cells to a type of leucocyte possessing all the characteristics of a 'large mononuclear.'

The typical large mononuclear leucocyte, as described by Ehrlich (*loc. cit.*), occurs in normal blood in very small numbers (one per cent.) and is also a constant easily recognizable form. It is a huge cell, two to three times the size of a red cell, and possessing a relatively large amount of usually palely staining cytoplasm and an oval eccentrically placed nucleus. The cytoplasm is finely, the nucleus coarsely, reticulated.†

Between these two extremes there is an intermediate group of cells possessing characteristics which do not conform to those of either division.

Many observers, however, do not strictly hold to Ehrlich's definition of a 'large mononuclear leucocyte,' but classify under this head almost any cell which is slightly larger than a lymphocyte, possessing at the same time the staining reactions, structure, and often bean-shaped nucleus of a 'large mononuclear.' By so doing they avoid a complex classification. It is the difficulty of determining exactly what combination of properties is sufficient to place members of this large unclassified group into either of the two main divisions which has produced a third class 'large lymphocyte.' The nuclei of any of these mononuclear cells may be 'incurved,' 'horseshoe shaped,' or even sub-divided.

Cells of the small lymphocyte type with irregular nuclei (rarely 0·5 per cent. in normal blood) are classified as lymphocytes. Cells of the large mononuclear type

* [illegible], Berlin, 1891.
† [illegible], Cassel, 1892, p. 1.

possessing 'horseshoe nuclei,' whether possessing sparse neutrophilic granulation or not, are often called 'transitional.' Whatever the name employed, the clinical fact remains that in malaria, the type of disease in which a 'large mononuclear increase' occurs, the cells which become more numerous are those mononuclear large cells possessing the following characteristics:—They have slightly basophilic, finely reticular cytoplasm, often possessing nodal thickenings which simulate granulation. Their nuclei, though usually taking a deeper stain than the protoplasm, are still not 'deeply basophilic,' and are coarsely reticulated and often irregular in shape. The size of such cells varies from one-half to even four times that of an erythrocyte, and the proportion between their cytoplasm and nucleus varies greatly.

Practically speaking, then, in malaria all the mononuclear elements, save the small and deeply basophilic lymphocytes, are increased, and it is solely for the purpose of presenting a simple definite clinical picture of the somewhat analagous changes in our cases of trypanosomiasis that we have adopted the following classification.

Neutrophiles.
Eosinophiles.
Mast cells.
Mononuclear small cells { Lymphocytes. / Lymphocytes with irregular nuclei.
Mononuclear* large cells { Large lymphocytes. / Large mononuclears. / Transitionals.

The headings neutrophiles, eosinophiles, mast cells, and lymphocytes need no explanation. The term 'lymphocytes with irregular nuclei' explains itself. We have classed as 'large mononuclears' only those cells which conform to Ehrlich's description, but have admitted as 'transitionals,' despite his definition, any large cell with a horseshoe shaped or doubled nucleus whether it contained sparse granules or not.

Inoculations

Infected material was, as a rule, diluted with approximately equal parts of the usual sodium citrate solution before inoculation.

Both intraperitoneal and subcutaneous inoculations were practised.

* The simplicity of the mononuclears into [illegible] cells, first suggested by the classification employed by Türk.† We have endeavoured, while taking advantage of its simplicity, to retain that greater precision of description ensured by a more complex classification. It will be at once seen that the division styled 'mononuclear large cells' includes both Ehrlich's 'large mononuclears' and other cells for which that name cannot be employed.

† Türk, K. [illegible], 1903.

II. HUMAN TRYPANOSOMIASIS

We have decided to retain the term Human Trypanosomiasis[15] as a convenient heading under which to discuss all cases in which the human subject is infected with trypanosomes, quite irrespective of the clinical symptoms characterizing the case under consideration. At the same time we recognize that a more extended subsidiary nomenclature may become necessary to indicate special morbid types of infection produced by these flagellata. For example, the type of illness now several times observed in Europeans infected with them has been called 'trypanosome fever.'

Distribution and Prevalence

Our first endeavour on reaching the Gambia was, naturally, to find a second case of trypanosomiasis.

A native child was known to have been infected, and we, therefore, determined to examine the blood of as many persons as possible, both black and white. Since parasites very similar to those already seen in man were known to occur in mammals, and since it was not impossible that they might be infected with the human trypanosome, it was necessary to include them in our examinations, all of which were made in the same way.

Our routine method for the detection of parasites in the peripheral circulation was, we are aware, imperfect. The exigencies of travelling, together with the length of time necessary to make preparations, prevented the constant employment of the centrifuge and animal inoculations as diagnostic methods. A coverslip preparation, for immediate examination, and a film for staining subsequently, were taken from each individual examined. Names were also recorded, and, in the event of infection, the case was recalled for further examination.

Distribution

The accompanying map of the Gambia, though not minutely exact, will give a very excellent idea of the localities in which we worked, and will, with the following table, indicate very precisely the numbers of natives examined in each district. Those towns in which infected individuals were found are in italics.

Date	Place	Number examined	Number infected
Sept. 11-26 ...	Bathurst	41	0
Oct. 15-23 ...	Cape St. Mary (patients)* ...	12	0
Nov. 1-Dec. 9 ...	„ „ („)	6	0
Oct. 24	Bakau	34	0
„ 25	Wasaloonka	23	0
Nov. 5	Sukuta	16	0
„ 7	*Lamwin*	35	3
„ 10	Busumballa	46	0
„ 11	Brefet	38	0
„ 13	Ga...	32	1
„ 15	Birkama	36	0
Dec. 6	Tunjina	14	0
„ 7 ...	Farrabubunta	32	0
„ 9	Kafata	43	0
„ 11	Bessat	19	0
„ 12	Brefet	38	0
„ 14	Somita	27	0
„ 17-20 ...	Vintang	84	0
Jan. 10	McCarthy Island	28	0
Mar. 29	„ „ (Labourers) ...	37	0
Jan. 19-21 ...	Kaur...	90	1
„ 24	Kwanko	15	0
„ 26	Edah	10	0
Feb. 1	Manna	31	0
Mar. 10	Maka (French territory) ..	62	0
„ 12	Boulenbou („ „) .	26	0
„ 13	Walia („ „) ...	59	0
„ 28	Sharnum	2	0
„ 29	Yarbutenda	13	0
„ 31	Sunkunda	16	0
April 7	Berif	4	0
„ 9	Bantonding	5	0
„ 10	*Fatotenda*	17	1
„ 15 ... ...!	Kanube	23	0
„ 22 ...	Sallikene	36	0
		1,043	6

* These were natives, ... various ailments, who, from time to time, came to us to ask for medicine.

Cases were found both near the sea and some two hundred and fifty miles up the river at practically the end of British territory. There was no evidence to show that natives living in any particular type of locality were especially subject to infection, neither do we find that the disease occurs in well-marked zones or 'belts.' For instance, although three cases of infection were found in thirty-five natives examined at Lammin, the natives of similarly situated villages, both neighbouring and distant, have been searched in a far more thorough manner and have failed to disclose a single parasite. We have found cases in low-lying, river-side villages surrounded by mangrove swamps; we have seen them in towns built on high ground and far from water, and observed them both near the sea coast and as far inland as Fatotenda. How far the disease extends beyond the colony of the Gambia we are unable to say, since only twice have we been able to examine natives in immediately adjacent French territory.*

Prevalence

We saw altogether six cases of trypanosomiasis in the native, and once found the parasite in the blood of a quadroon, who can almost be considered a European, since his boyhood and a large part of his life were spent in England.

We examined altogether one thousand and forty-three persons in the Gambia. The percentage of infection given by these figures is, we are convinced, smaller than is actually the case.

Our reasons for holding this opinion are the following:—

(1) Many cases have certainly escaped identification both because of the scanty numbers in which the parasites are ordinarily seen in human beings and because of the periodicity with which even these are absent from the peripheral circulation.[14, 15, 50]

(2) The majority of the natives examined were apparently healthy children and young adults, who could be persuaded by small bribes to allow their fingers to be pricked. It was in many places extremely difficult to obtain blood from older persons who are possibly more frequently infected. In any case the total number of examinations is too small to permit one to make a dogmatic assertion as to the percentage of infection existing among the Gambian natives.

Symptoms

Since in both East[3] and West Africa natives infected with trypanosomes have shown few or no symptoms; and since a few Europeans in whose blood the parasites have been demonstrated have all suffered in roughly the same way, we think that it will be well to describe the cases observed by us in the Gambia according to the race of the individual affected.

* We examined the blood of some two hundred and thirty individuals while at Dakar and St. Louis. Seventy-five were hospital patients who had come from various parts of Senegal and the Soudan; the remainder were children—the great majority of them inhabitants of St. Louis. Twenty-eight of the hospital patients were white, the remainder Africans. The European cases, usually invalided for malaria, were examined with especial care. In the fresh preparations from these cases no trypanosomes were seen. The stained films taken from each individual have not yet been searched.

Clinical Descriptions of Two Cases of Trypanosomiasis in Europeans

Notes by Dr. H. E. Annett

Case 1.—H.K., an Englishman, aged forty-two, for six years in the Government employ as a master of the Government steamer plying up the Gambia River, on the West Coast of Africa.

The illness dated back from May, 1901, when, after a period of heavy duties, he completely broke down and was admitted into hospital at Bathurst. There was a previous history of occasional attacks of malarial fever. It was during his stay in hospital at Bathurst that peculiar worm-like bodies were seen in specimens of blood, the nature of which Dr. Forde was unable to recognize.*

The illness was at first sight diagnosed as malarial fever, but, proving quite resistant to the administration of quinine, and presenting other peculiar characters, this diagnosis was abandoned. The peculiar symptoms were: 'irregular patches of a congested or cyanosed character appearing on different parts of the body, the colour slowly returning after pressure. An oedematous condition . . . . most marked on the face below the eyes, varying in degree from a scarcely noticeable swelling to well-marked puffiness: a condition also noticed in the lower part of both legs and around the ankles, but only in a slight degree. The respirations always . . . . from twenty to thirty, periodical accelerations occurring quite independently of any rise in temperature, and whilst the patient was quietly lying in bed. The pulse was also accelerated, varying from seventy to one hundred and twenty. There seemed to be no relation between the rate and the temperature. . . . . The beat was always strong and regular. The appetite was bad all the time, and though a fair amount of liquid nourishment was taken daily, the patient gradually lost weight and colour and became very emaciated. The liver and spleen were practically normal in size and position. The temperature was irregularly intermittent with two or three days of normal or subnormal periods, and unaffected by any drugs.'

After three weeks in hospital, K. was invalided home to England, and arrived in Liverpool in a very weak condition. Until August 12 he remained at home under the care of his own medical attendant, and on that date was admitted into the Liverpool Royal Southern Hospital, under the care of Dr. Macalister. He complained of general weakness and lack of energy. Briefly, his chief symptoms and physical signs were:—'Subnormal temperature; slight headache, but no pain; furred tongue; fair appetite; no vomiting; constipation; pulse (on admission), 120, falling to about 92, regular in time and force, low tension, fair volume; heart sounds weak and distant, otherwise normal; respiration (on admission), 32, falling later to 20; slight dyspnoea on exertion; lungs normal; weakness in legs; some wasting; knee jerk and plantar reflexes present and easily obtainable; sensation

* *Thompson Yates Laboratories Report*, 1902, Vol. IV, Part ii.

normal; urine normal in quantity, sp. gr. 1032, no albumen, no chlorides; liver slightly enlarged, but not tender; spleen normal in size; considerable tenderness over the splenic area.'

The patient remained in hospital for fourteen days, during which period the following further observations were noted:—The temperature curve* shewed three short periods of pyrexia, during which the temperature reached 101° to 102° F. in a few hours, and fell rapidly to normal, with intervals of about three days apyrexia. On one occasion the spleen was felt below the costal margin. The pulse and respiration were always frequent, and varied on exertion and with temperature. Generally, however, their rates were quicker than when in hospital at Bathurst. No malarial parasites were found in specimens of his blood during this time.

The patient remained in England recruiting his health for some months, and returned to Bathurst in December, 1901. On the voyage out he was very ill with what was diagnosed as pneumonia of an atypical character. The sputum was described by the ship's medical officer† as more of the nature of pure blood.

Immediately on his return to the Gambia, K. was placed on the sick list. He had not yet recovered from his attack on board ship, and was very thin and weak, and easily fatigued. On examination by Dr. Forde and Dr. Dutton, on December 18, his temperature was 100·4° F.; pulse, 96, respirations, 34.

'His chief symptoms were weakness, marked loss of weight, inability to walk far without feeling very tired Patient did not complain of any definite symptoms. There was no pain nor headache, but a little loss of appetite, and sleeplessness at times. On December 16 he had slight bleeding from the nose. There was no cough, but some dyspnoea on exertion. The general facial aspect, which had been remarked upon by his friends, was very striking. The face was puffy and congested. The eyes were sunken, the conjunctivae had a watery appearance, but were not congested; the most prominent feature was the puffiness of the lower lids, which were distinctly oedematous. On examining the body generally, one noticed that the skin appeared cyanotic, especially on the chest and thighs; pressure made with the hand caused a white mark which took some little time to disappear. There was some puffiness around the ankles, the skin pitting slightly on pressure; the skin was dry; no jaundice.

No cough, no expectoration. Respirations were increased in frequency. This frequency of the rhythm was very noticeable on the slightest exertion or excitement.

During the time of these observations, his respirations were never below 20 per minute, the usual being from 25 to 30; they were never laboured. Chest somewhat barrel-shaped; breath sounds, normal; no dulness; slight emphysema, otherwise the lungs seemed healthy. Pulse frequent, 96; regular in time and force; tension, normal; artery, normal. The pulse was always frequent and hardly ever

* The chart and details of the case are given in a 'Preliminary note upon a case of a Trypanosome occurring in the blood of man.' J. Everett Dutton. *Thompson Yates Laboratory Report*, 1902, Vol. IV, Part ii.

† *Liverpool* [illegible] Jan. 3, M[illegible] 2

less than 90, even when the temperature remained low. Heart apex in fourth interspace, four inches from the middle line ; impulse distinctly seen, not diffuse ; cardiac dulness commenced about at the third rib and did not extend to the right beyond the midsternal line ; cardiac sounds, normal, no adventitious sounds. Appetite fair, no diarrhoea ; had to take an occasional aperient. No pain on abdominal palpation. Liver dulness, four-and-a-half inches in nipple line, extended just below costal margin. Slight bulging over the splenic area ; dulness increased diagonally, measured seven inches ; the edge of the spleen could be felt below the costal margin ; no tenderness on palpation. In nervous system nothing abnormal could be detected. No definite enlargement of lymphatic glands. Urine normal in quantity, rather high-coloured ; Sp. Gr., 1,020 acid ; no albumen ; no casts ; some phosphates.'

During the next few weeks, while the patient was still on the sick list, observation of his condition shewed a temperature, pulse, and respiration similar to what had previously been recorded in England. The temperature chart showed periods of slight pyrexia lasting three or four days, with intervals of four or five days in which the temperature remained below normal. During this time K. was never confined to his bed, and was able to take short walks ; his appetite was distinctly good during the apyrexial periods, and the pain over the spleen disappeared.

On December 26, he was sent to Cape St. Mary, seven miles from Bathurst, on the sea coast, and here he quickly improved. He still, however, shewed a slight temperature nearly 100° F. at times, some puffiness about the eyes ; slight injection of the conjunctivae ; some weakness in legs ; and slight oedema about the ankles. He was able to resume his ordinary duties, seeming to be much improved.

It was during this period that the true nature of the blood parasite was made out by Dr. Dutton, and it was noted that during the pyrexial accesses the parasites were more numerous in the blood than during the apyrexial intervals, when occasionally none could be found during an ordinary examination.

'A blood count on December 18 (four hours after food) shewed red corpuscles, 3,850,000 ; white corpuscles, 12,000 per c.cm. ; haemoglobin (Gower's apparatus), 76 per cent. A differential count of the white corpuscles made on several occasions, both when parasites were present and absent from the peripheral blood, shewed an increase of lymphocytes at the expense of the polynuclear cells, the relation being generally about fifty per cent. of the latter to forty per cent. of the former.'

On July 25, 1902, K. again arrived in England, invalided home from Bathurst. The chief points of his condition, taken from notes made at the time by Dr. Dutton, were : 'Although the temperature and pulse had not been regularly taken, K. described short periods of fever and of feeling out of sorts. He looked considerably thinner,

and said he had lost weight. He also complained of weakness of the legs. He had had occasional bleeding from the nose, and had noted some swelling about the ankles. The eyelids and nose were swollen and oedematous. Appetite fairly good. Some tendency to constipation. Respiration became troublesome and distressing on slight exertion.

On examination, the most noticeable feature was the presence of the erythematous-looking, raised rash, on the skin of the chest and back, thighs, and arms. There was marked dyspnoea. Pulse, 120, regular, poor tension. Respirations, 30. Heart slightly dilated. Urine, 1,016, acid; no sugar; slight trace of albumen; of normal quantity. Patient's weight, 158 pounds. Examination of blood: Sp. Gr., 1,057; red corpuscles, 4,400,000; white, 6,800. Haemoglobin, 90 per cent. Temperature varied only between 97° and 100° F. From one to three parasites could be detected in every cover-glass preparation of blood taken from the finger. It was noticed that tissue juice obtained from the swollen oedematous lower eye-lid, or from the raised erythematous patches contained a comparatively larger number of trypanosomes than the peripheral blood.

Up to December 29, the case continued to follow the chronic course, which apparently characterizes the disease in Europeans. The increased frequency of pulse and respiration, the peculiar congested areas of the skin, the local and fugitive oedemata, the enlargement of the spleen, and the irregular rises of temperature continued until the end. But under treatment, which, after the apparently useless administration of quinine and arsenic in large doses, consisted of the admininistration of urotropin in doses increasing from five to ten grains three times a day, the patient increased in weight (from 158 pounds to 168 pounds), and improved considerably in muscular strength. Slight rises of temperature, reaching sometimes 102° F., at intervals of from one to ten weeks, lasting only a few hours, and occasionally some increased difficulty in breathing produced some distress.

The patient was usually in fairly good spirits, although having some idea of the nature of his condition; but on rare occasions he manifested very considerable depression and indifference to living. There was always a tendency to constipation, corrected by regular use of aperient waters; and short, smart attacks of severe pain over the spleen at times caused him to remain indoors. Otherwise during this time he lived much in the open air, and practised the most regular and healthy habits.

During this time parasites were very scanty in the peripheral blood, and at some examinations appeared to be entirely absent, at others two or three only could be discovered after a long examination of several blood films. But the inoculation of animals (white rats and monkeys) demonstrated their presence.

On the morning of December 29, acute symptoms developed, ushered in by an indefinite rigor, the temperature being stated to be 99·6° F. In the

evening the temperature was 104°, the pulse, 126, and respiration, 28. On the morning of the next day, the temperature, which had continued high during the day, was 105° F.; pulse, 130; respiration, 30. There was some delirium, and the patient recognized his friends with difficulty. The respiration became of CHEYNE-STOKES character, and there was some difficulty in utterance; the pupils appeared normal. An examination of the patient revealed nothing to account for the acuteness of the symptoms, which indicated some cerebral disturbance. The patient seemed to be *in extremis*, but rallied considerably during the next day, the temperature gradually falling to 102·5° F., while the pulse and respirations remained about the same; there was no delirium. On the morning of January 1, the temperature fell further to 101° F., but the respirations became still more frequent, reaching 60 to 70, until death occurred, the patient remaining conscious almost to the end. An autopsy was unobtainable.

Case 2.—The second 'European' case observed by us was Mr. Q.

He was a quadroon and was educated in England, though born in Gambia, where he has been resident for the past twenty-four years as a trader. He spent a good deal of his time on or near the river and in swamps while occupied in getting out either logs of mahogany or loads of piassava fibre. For the two years before his death he had lived on the river's bank at his Sakuta factory, situated roughly one hundred and thirty-five miles from the sea. His house was built upon a bit of fairly dry ground about three feet above high tide. It was quite cut off from the main land by a huge swamp, which was impassable except in the middle of the dry season. Mosquitoes of all sorts bred and multiplied in this swamp, and they, with Tabani and innumerable Glossinae, were a continual pest.

During his rough life he very frequently lived for long periods in native villages, almost as a native. From these circumstances it can be gathered that he was very constantly exposed to, and very frequently bitten by all sorts of blood-sucking insects. In spite of this insanitary life Mr. Q. had, of late years at least, been very well, and had never suffered from 'fever,' although when he first came to the Colony he had had a good deal of 'malaria.' His habits were fairly regular. He smoked but little, and only occasionally indulged in too much alcohol. He was rather a heavily, sturdily-built man, aged fifty-six years. His height was five feet six inches, and his weight, in health, one hundred and ninety-four pounds. He was active in habits and robust in constitution, and, except during his periodic attacks of fever, felt quite well.

When we first saw him in October, 1902, he complained of not being well, and said that:—

(1) He had lost flesh, weighing only one hundred and fifty-six pounds, instead of one hundred and ninety-four pounds as formerly. Weight

was lost gradually. Six months previously he had weighed one hundred and seventy-four, and two months before one hundred and sixty pounds.

(2) He complained of constant accesses of intermittent slight fever (going up to 101° F.), which was not checked by quinine. He habitually used a clinical thermometer and took ten grains of quinine every two days; so this history of fever may be assumed to be correct.

(3) He became easily fatigued. He lost breath easily. His legs seemed sometimes to be weak, and he occasionally had palpitation.

(4) He had, from time to time, pain in his loins, particularly after exertion, and, twelve months previously, in the splenic region.

He attributed the commencement of his illness to the bite of some insect which he received on his thigh, a year before (October, 1901), while at closet in Bathurst. This bite became livid and tender, and swelled up in a very short space of time to the size of a walnut. It was followed six hours later by an attack of 'ague,' which developed into 'fever' and kept him in bed for some days. Since this illness he has never been himself.

Clinical Examination.—In October, 1902, he had all the general appearances of a healthy man—his figure was rotund, his face was not emaciated, and he certainly did not look like a man who had lost forty-two pounds during the preceding year. His friends, however, told us that he had lost a great deal of flesh and was much less stout than he formerly was. The exposed parts of his body were darkened from exposure, although his trunk, which was much marked by recent insect bites, was quite white. His legs were deeply scarred and pigmented by former 'bush boils and ulcers.' The blotchy erythemata seen[15, 50, 49] in the first European cases were not present, but vasomotor reaction was easily excited and his skin was markedly dermatographic. Although persistent reddening of the skin was noticed in places pressed upon by clothing, as, for example, around the waist and on the chest, we never observed any of that doughiness of the skin or the local transitory maculae which have been such marked characteristics of the other European cases.

Slight pitting on pressure was observed on the shins and ankles. Mr. Q. was very certain that there had never been any puffiness of his eyelids.

No organic lesion of heart or lungs was detected, although the rapidity of both pulse and respiration during rest was increased. There was no history of haemorrhages. His appetite was good and his bowels regular. The liver extended 2 cm. below the costal margin but was not tender. The spleen extended 3·5 cm. below the costal margin and was rather tender on firm pressure.

It is most unfortunate that we were never able to obtain a specimen of urine for examination from this case. Sexual impotence which had been a feature in the first European case was absent here.

October 26 : Pulse, 99 ; respiration, 18 ; temperature, 99·4° F. (Taken while sitting). Four to seven trypanosomes were present in each coverslip preparation at this date.

Mr. Q. was again seen on January 19 at his Sakuta factory. He then felt much better. Shortness of breath and palpitation had left him, and he had gained flesh, his weight at this time being one hundred and seventy-five pounds.

He had taken none of the solutions of arsenic which Dr. CHICHESTER had prescribed for him in October, 1922, and ascribed his improved condition to quinine and patent medicines which he had used rather freely. One of the latter consisted of methylene blue tablets.

Objectively his condition was the same as it was three months previously.

We again saw no macular erythemata nor marked oedema. There was still slight pitting over shins and ankles, slight temperature and frequency of pulse and respiration. Pulse, 104 ; respiration, 18 ; temperature, 98·2° F.

About five c.cm. of blood was centrifuged, in it nineteen trypanosomes were found.

A blood count showed—

Red cells - -	[illegible]
White cells - - - -	8,000
Haemoglobin - - -	96 per cent.

Differential counts of leucocytes made on preparations taken on two different dates were as follows :—

Blood count from five slides November 9, 1902, 1,100 cells counted. Stained with ROMANOWSKY, effect not good, as no granules are seen in mononuclears.

Neutrophiles - -	62·76 per cent.		
Eosinophiles - -	6·45 per cent.		
Mast cells - -	0·72 per cent.		
Mononuclear, small cells,	19·54 per cent.—	Lymphocytes -	19·36 per cent.
		„ with irregular nuclei,	0·18 per cent.
„ large cells	10·53 per cent.—	„ large,	6·81 per cent.
		Large mononuclear,	0·18 per cent.
	100·00	Transitionals -	3·54 per cent.

Blood count January 19, 1903, eight hundred cells from five slides were counted, ROMANOWSKY effect good in two of these.

Neutrophiles - -	53·26 per cent.		
Eosinophiles - -	5·25 per cent.		
Mast cells - - -	1·25 per cent.		
Mononuclear, small cells,	26·62 per cent.	—Lymphocytes -	26·25 per cent.
		„ with irregular nuclei,	0·37 per cent.
„ large cells,	13·62 per cent.	—Large lymphocytes,	9·00 per cent.
		„ mononuclears,	0·25 per cent.
	100·00	Transitionals -	4·37 per cent.

About four per cent. of lymphocytes contained granules.

„ eight „ of large lymphocytes contained granules.

On March 20 we received a message saying that Mr. Q. was very ill and asking us to go to him.

Unfortunately we reached Sakuta too late to see him alive. His native wife refused to allow an autopsy, and we were able to gather but a very meagre history of his last illness from those neighbouring traders who had seen him and from his native servant. We were told that his last illness had commenced with a 'cold and fever' on the 16th of March. Two days later he went to bed complaining of headache and pain over the spleen. On the 20th he was 'unconscious, and unable to speak or swallow, his throat seemed to pain him,' and he died during the early morning of the 22nd, three hours before we reached him. No more accurate information than this could be obtained from the more or less conflicting reports proffered us.

We were permitted to examine the body. P.-M. rigidity and hypostatic congestion of dependent parts were marked. There was the usual slight oedema of shins and ankles only. No fluid was found in the peritoneal or pleural cavities by aspiration. No parasites were found in blood taken with a syringe from the spleen and heart. A rat inoculated with heart's blood taken at this time has never become infected.

The original disease in this case commenced in October, 1901, so that its duration was almost the same as that of Mr. K.'s illness, viz., one-and-a-half years.

The regrettable incompleteness of our notes on this case is largely due to the patient's unfortunate objection to a systematic examination.

CASES OF TRYPANOSOMIASIS OBSERVED AMONGST THE NATIVES OF GAMBIA

Case 1.—Woman, age thirty-five years, living at Lammin Village, on the Lammin Creek, Kommbo.

History.—The woman was married and had one child seven years old. She was a native of the town.

She complained of feeling weak and ill, and asked for medicine. She said her illness commenced a month ago with a cough and fever, the fever at times, for a day or two, confining her to her hut. She related that during the rains she had been ill with fever and headache and that she had got much thinner.

Note.—History unreliable.

Clinical Examination.—Patient was a spare Mandingo woman, showing no signs of wasting and no skin lesions. There was a slight oedema around ankles, the skin 'pitting.' One lymphatic gland in the left axilla, though freely movable, was distinctly enlarged; all the other superficial glands were palpable.

The liver, spleen, heart, lungs, kidneys, and intestines were all normal.

Pulse, 93; respiration, 18; temperature not recorded.

Blood.—Coverslip preparations were examined on two successive days. The first observation showed one, the second five parasites to the coverslip.*

Differential Count of Leucocytes

Neutrophiles - -	24·5 per cent.		
Eosinophiles - -	6·75 per cent.		
Mast cells - - -	·0 per cent.		
Mononuclear, small cells,	42·00 per cent.	—Lymphocytes -	39·5 per cent.
		,, with irregular nuclei,	2·5 per cent.
Mononuclear, large cells,	26·75 per cent.	—Large lymphocytes,	19·25 per cent.
		Large mononuclear,	1·5 per cent.
		Transitionals -	6·0 per cent.
	100·00 per cent.		

Four hundred cells from one slide were counted.

Case 2.—Boy, age nine years. Living at Lammin village.

History.—He had never been far away from the village. Though he was said by his parents to be weakly he had had no serious illness, and worked with other boys of his age on a ground-nut farm in the neighbourhood.

No definite history could be obtained.

Clinical Examination.—Patient was a rather poorly-developed lad. Nothing abnormal was detected, except the enlargement of the spleen usually seen in natives of this age. This boy could run and wrestle as well as other boys without any marked increase in the frequency of pulse or respiration.

* As previously stated three-quarter inch square coverslips were used throughout our work.

Blood.—Examined on one occasion showed one trypanosome to coverslip preparation.

Differential Count of Leucocytes

Neutrophiles - -	23·5 per cent.	
Eosinophiles - -	5·75 per cent.	
Mast cells - - -	0·25 per cent.	
Mononuclear, small cells,	57·50 per cent.	—Lymphocytes - 56·75 per cent.
		„ with irregular, abnormal nuclei, 0·75 per cent.
Mononuclear, large cells,	13·00 per cent.	—Large lymphocytes - 10 per cent.
		Large mononuclears, 0·25 per cent.
		Transitionals - 2·75 per cent.
	100·00 per cent.	

Four hundred cells from two slides were counted.

Case 3.—Girl, age fifteen years, living at Lammin.

History.—The girl was a water carrier and had never been far away from the village. She said she had never been ill in her life. She felt perfectly well and had had no fever.

Clinical Examination.—Revealed nothing abnormal, beyond a slight enlargement of the spleen. Patient was a very well-developed girl.

Pulse and respiration were normal, and there was no fever.

Blood.—Examined on one occasion showed twenty-three trypanosomes to coverslip.

Differential Count of Leucocytes

Neutrophiles - -	34 per cent.	
Eosinophiles - -	10 per cent.	
Mast cells - - -	1·75 per cent.	
Mononuclear, small cells,	44·25 per cent.	—Lymphocytes - 43·5 per cent.
		„ with irregular nuclei, 0·75 per cent.
Mononuclear, large cells,	10·00 per cent.	—Large lymphocytes, 4·25 per cent.
		Large mononuclear, 1·0 per cent.
	100·00	Transitionals - 4·75 per cent.

Four hundred cells were counted from two slides.

Case 4.—Boy, age twelve years, living at Gunjur, a large town not far from the coast, in the Kommbo district.

History.—This boy came to Gunjur last year (1901), before the rains, from near Rufisque, in Senegal. A very indefinite history of fever was given by his guardians, who mentioned that the boy suffered from enlarged glands in the neck, and would

soon have them cut out as a prevention against sleeping sickness.* The boy maintained that he was perfectly well.

Clinical Examination showed a sturdily built lad. All his organs were normal except the spleen, which could be felt 6·5 cm. below costal margin. There was no tenderness on palpation.

The axillary, inguinal, sternomastoid, and submaxillary lymphatic glands were all very much enlarged, not tender, hard, and freely movable. One in the left axilla was the size of a pigeon's egg.

Pulse varied in frequency, was usually about 112 ; respiration, 26 ; temperature 101° F.

Blood.—Was examined on two consecutive days. The first observation showed one parasite to coverslip ; at the second six were seen.

Differential count of Leucocytes

Neutrophiles - -	29·50 per cent.		
Eosinophiles - -	8·87 per cent.		
Mast cells - - -	0·25 per cent.		
Mononuclear small cells,	46·26 per cent.	—Lymphocytes -	41·64 per cent.
		„ with irregular nuclei,	4·62 per cent.
Mononuclear large cells,	15·12 per cent.	—Large lymphocytes,	9·12 per cent.
		Large mononuclears,	0·50 per cent.
		Transitionals -	5·5 per cent.
	100·00		

Eight hundred cells were counted from two slides.

Case 5.—A Jollof Mohammedan man, age thirty-five years, living at Kuntur, a riverside village in McCarthy district.

History.—He was born at Bantanding, near Barra Point, but as a child lived in Bathurst.

He was at the age of fourteen years apprenticed as a sailor to one of the cutters plying on the Gambia River and worked up to be a captain.

For the past five years he had lived at Kuntur all the year round, working at one of the ground-nut 'factories.'

He had never had any serious illness, but at times had had what he called 'strong fever,' generally in the morning, lasting for three or four hours. Last rainy season he was laid up with headache and 'fever' for three days ; he said he had never had headache before, and at the time noticed his 'eyes' were swollen. The swelling of the left eye persisted for two weeks.

* The Gambian natives recognize sleeping sickness, and assert that they can foretell its onset. They believe that an invariable prodrome is an enlargement of the lymphatic glands, particularly of the anterior cervical and sub-maxillary groups. The excision of enlarged glands, to prevent sleeping sickness, is one of their few surgical operations.

He had had slight attacks of 'fever' during the past year, but they had not prevented him from working. Though he was a powerful man he said that he had lost strength during the past year and that he was not able to lift as heavy weights as usual. When at work and even when not working he sometimes 'breathed hard.' For about a month he had had pain in his right side and back, which he believed was due to a strain caused by lifting a heavy weight.

History reliable; an intelligent man.

Clinical Examination.—Patient was a very well-developed man. Muscles were good, appetite good, bowels regular. Respiratory system normal. Heart, slight accentuation of first sound at apex. Liver normal. Kidneys normal, urine could not be obtained for examination. Spleen extended 1·25 cm. below costal margin, not tender. All lymphatic glands were slightly enlarged, especially the inguinal groups, but freely movable. Some slight 'pitting' over tibiae and dorsa of feet, especially the left. No varicose veins. There were some slight scars on the shins and an old injury to the left little toe (crushed). Some slight puffiness of the lower eyelids, especially the left, was noticed.

Pulse, 82; respiration, 20; temperature, 99·8° F.

Blood.—One examination showed eleven trypanosomes to cover—

Red cells - - - -	4,600,000
White cells - - - -	7,500
Haemoglobin - - -	77 per cent.

Differential Count of Leucocytes

Neutrophiles - -	43·75 per cent.		
Eosinophiles - -	5·42 per cent.		
Mast cells - - -	0·71 per cent.		
Mononuclear, small cells,	29·42 per cent.	—Lymphocytes -	29·14 per cent.
		,, with irregular nuclei,	0·28 per cent.
Mononuclear, large cells,	20·7 per cent.	—Large lymphocytes,	13·42 per cent.
		Large mononuclears,	2·0 per cent.
	100·00	Transitionals -	5·28 per cent.

Seven hundred cells were counted from five slides.

Case 6.—Mandingo youth, age twenty-two years, living at Fatotenda on the upper river.

History.—Was born at Medina, five days' march to the south from Fatotenda. He was a student, and although he had travelled a good deal in French territory to the south of the Gambia he had never, until he came to Fatotenda in January, 1903, either lived on the river or done any sort of manual labour.

He said he had never had any illness and that he was quite well and strong. He complained only of a small chronic ulcer on the left foot. He stated that for the last nine months he had occasionally had a slight nose bleeding, which sometimes lasted subcontinuously for two days.

Clinical Examination.—The patient was a well-developed lad. Muscles were good. Nothing abnormal was detected, with the exception of a slight enlargement of the spleen, which extended 1·5 cm. below the costal margin. All the glands were palpable, but none were markedly enlarged. There was a slight injection of the nasal mucous membrane, and the tonsils were slightly enlarged.

Urine, slightly acid, 1,007 ; colour, normal ; no haemoglobin. Albumin and a small amount of pus were present.

April 10. Temperature, 100·1° F. - Pulse, 84 - Respiration, 20.
„ 15. „ 99·4 F. - „ 104 - Respiration, 22.

Blood.—Examined on two occasions.

April 10. Two trypanosomes to cover were seen.
„ 15. In three coverslip preparations, one trypanosome and two specimens of *F. perstans* were seen.

Red cells - - - -	3,950,000
White cells - - - -	8,000
Haemoglobin - - -	68 per cent.

Differential Count of Leucocytes

Neutrophiles - -	40·6 per cent.	
Eosinophiles - -	13·5 per cent.	
Mast cells - - -	0·3 per cent.	
Mononuclear, small cells, 32·8 per cent.	—Lymphocytes -	32·6 per cent.
	„ with irregular nuclei,	0·2 per cent.
Mononuclear, large cells, 12·8 per cent.	—Large lymphocytes,	11·2 per cent.
	Large mononuclears,	1·1 per cent.
100·0	Transitionals -	0·5 per cent.

Two thousand five hundred cells from six slides were counted. Both Ehrlich's tri-acid and Romanowsky's stains were used.

Discussion of Native Cases

Taken as a whole a consideration of the native cases reveals no marked constant characteristic.

Enlargement of the spleen was observed in the younger cases. But this is without significance since that organ is enlarged in nearly all Gambian native children.

Enlargement of lymphatic glands is also by no means unusual in native children.

The history of possible loss of weight and strength with fever was given in four cases; definitely in only two.

The remaining cases believed themselves to be perfectly healthy. Two boasted of their extraordinary vigour, and neither of the adult males were impotent. In appraising the value of the past history of these cases, we must remember that a native does not reckon time or observe himself so accurately as does a European. In addition, he will very often say what he imagines will please his questioner. Even if his story of past fevers and loss of weight, during the rainy season, is correct, it must not be forgotten that there are many other diseases which produce like symptoms.

We must, therefore, rely altogether on our objective examination, and this, unfortunately, was necessarily curtailed because travelling made it impossible to keep each case under observation for any length of time.

Taking all our facts into consideration, we believe the disease, as it occurs in natives, to be a peculiarly mild one, and that it is at present impossible to recognize it clinically.

The accelerated pulse and respiration rate, slight rise of temperature and past history of fever occurred not unfrequently amongst many of those in whom no trypanosomes were found.*

The abnormal results of the blood counts must not be assumed to be specific. An enormous percentage of these natives were infected, in varying degree, with filariae, and all may be assumed to have had intestinal parasites. The quantitative estimation of blood cells and haemoglobin shows a constant diminution of these elements as judged by the European standard. What the normal for an African may be we have no means of determining.

The differential leucocyte counts show a constant increase of eosinophiles, mast cells, and mononuclear elements. The proportional increase being greatest in the cases of the eosinophiles and mononuclear large cells.

In slides coloured by the previously mentioned modification of Romanowsky's stain many of the mononuclear cells were seen to contain deep, rich lake-coloured granules. The number of granules present in each cell ranged from, perhaps, twenty to eight or ten or even less. Their size and shape varied as much as their number. They varied from regular oblongs, as long as eosinophile granules, to mere points of colour. A small unstained area was often seen to partially surround these granules.

* A series of pulse rates taken at random from apparently healthy children, in whom no trypanosomes were found, showed that an increased pulse rate, ninety to one hundred, was not at all uncommon.

The granules occurred on an average in thirty to fifty per cent. of the large mononuclear.

„ „ „ „ two to seven per cent. of the small lymphocytes.

„ „ „ „ eight to twelve per cent. of the large lymphocytes.

In specimens stained by Ehrlich's or Romanowsky's methods and fixed by any of the three previously mentioned methods, circular, refractile, non-staining, and sharply circumscribed areas were not infrequently seen in both the cytoplasm and nucleus of the leucocytes.

Their most usual situation was, however, in the cytoplasm close to the nucleus. They varied in diameter greatly, being usually about 0·5 to 1·0 μ in width. They occurred in about two per cent. of all leucocytes, but were, however, more numerous in the mononuclear elements.

The slight virulence of this trypanosome and the consequent lack of symptoms has frequently suggested to us the possibility that the natives in this disease may bear the same relation to the European as does the wild game of Central Africa to domestic animals in the tsetse fly disease.

We have had no opportunity of investigating the course of the disease—if we can call it a disease—in the native, but the ages of those infected indicate that there can be no absolute acquired immunity. It would be rather curious if the woman at Lammin or the man at Kuntur had only recently become infected for the first time after having been exposed to infection from childhood. We think that the varying ages of the various cases is another point in favour of our belief that the parasite frequently occurs in the natives, but appears in a periodic manner in their peripheral circulation.

III. EQUINE TRYPANOSOMIASIS

The first trypanosome which we found while in the Gambia was in the blood of a horse, and this is the only animal in which we have seen a certainly *pathogenic* trypanosome.

Out of thirty-six horses examined, ten were found to be infected. The parasites derived from three of these animals have been, and are still being, studied. They, as far as we can see, are all of the same variety, and do not correspond in every respect with any of the described trypanosomata, although in a general way they resemble those species already described as pathogenic to horses.

Pending a further study of their properties, we shall describe them as one species, under the style of 'The Gambian Horse Trypanosome.'

Distribution and Prevalence

One of our first cares in the Gambia was to obtain data showing the amount of live stock of all sorts in the country, and to learn in exactly what localities the various animals throve or not.

To aid us to this end, Sir George Denton, K.C.M.G., the governor of the Gambia, very kindly sent out a circular letter, containing questions on the subject, to all the District Commissioners.

From the information thus acquired, together with that obtained from traders and natives and supplemented by our own observations, we have drawn the following conclusions :—

1. Equine trypanosomiasis in the Gambia is a very chronic disease.
2. It occurs throughout the colony, and is possibly more prevalent near the river, especially during the rainy season.
3. Cattle and other domestic animals are not known to suffer from the disease.

The total number of horses in the Gambia is not large, probably not more than 1,000 altogether. In some districts there are very few, in others there are absolutely no horses nor, indeed, cattle. The natives explain this by their poverty, saying that they cannot afford to buy horses and cows. Others, again, are fishermen or pagan agriculturists and carriers, *e.g.*, the Jolahs ; and do not keep live stock other than goats, which thrive everywhere. There are more horses on the northern bank of the Gambia, particularly of the upper river than on the southern.

The latter is said to be more unhealthy for horses than the district to the north of the river. In Fogni and Kommbo there are very few horses.

We believe that the scarcity of horses in these two latter districts is due to trypanosomiasis of such a chronic course that the natives do not recognize that their horses are ill. They say that horses usually die by becoming gradually thin and weak, though eating heartily, until they die through sheer inanition. This is precisely the course of horse trypanosomiasis as we have seen it.

If the disease were more acute it would be recognized, for the natives are not altogether unobservant. They recognize various types of disease in their animals, and consequently practice rude veterinary medicine.

They describe two horse sicknesses (we have seen neither), characterized the one by 'swollen stomachs and legs and, rarely, by loss of hair from the neck,' and the other by 'pain in the head, running from the eyes and nostrils, and lack of appetite.' The latter is called 'Jukundo,' and about fifteen to twenty years ago it caused an epidemic, during which a very large number of horses died.

Herdsmen recognize diseases among their herds; in one instance a Fulah cattle owner asserted that it was *Jolofin Jolo* (*Glossina palpalis*) which killed his cattle. The native is far from blind to the well-being of his stock, and the chronicity of the horse disease will be still better appreciated when it is remembered that he fails to recognize it.

A large number of horses, perhaps three hundred or more, are yearly imported into the Gambia from towns in French territory. They come from all parts of Senegal, principally from Galum, Fotatora, and Niani. We have been told that many of them die within a year after reaching English territory, particularly if they have not been sent away from the river's bank for the rains, as is the usual native custom. During the wet season all horses, donkeys, and cattle are sent to higher ground several miles distant from the river. Whether this is done altogether with the idea of removing the animals from an unhealthy neighbourhood or partially to obtain better grazing we cannot say. Certain it is that during the rains many natives absolutely refuse to bring their live stock to the river. The tall red Soudan sheep will not live on the river, and invariably die within three or four months. Sheep brought to the river are, for this reason, always slaughtered at once. While in the Gambia we examined the blood of many domestic animals, goats, cattle, dogs, donkeys, and sheep for trypanosomes, but always with negative results.

The number of horses which were examined was very small. It was often much easier to persuade a native to give a drop of his own blood than to allow his animals to be pricked. In addition, there are never more than two or three horses in a village. We did not travel a great deal, and so saw comparatively few horses.

The following table shows the number of horses examined and the number found to be infected in each locality :—

TABLE SHOWING FREQUENCY WITH WHICH NATIVE HORSES ARE INFECTED WITH HORSE TRYPANOSOME IN THE COLONY OF THE GAMBIA

Owner of Horses	Number Examined	Number Infected	Cases
Owned by natives, Bakau and Cape St. Mary District	6	5	i, ii, iii, iv, v
Officers of West African Frontier Force, Bathurst	4	2	vi, ix
Governor Denton, Bathurst	3	1	x
At Maka, French Territory, French Commandant, Monsieur H. Porthes	8	2	vii, viii
Sallikene	1	0	
Sakuta, Kommbo	2	0	
Lammin	2	0	
Birkama, Kommbo	4	0	
Vintang	3	0	
Bathurst Trading Co., Bathurst	2	0	
McCarthy Island	1	0	
	36	10	

The total number examined is again too small to permit of a final conclusion as to the prevalence of horse trypanosomiasis in the Gambia. That a large percentage of horses are affected there is, we believe, no doubt. We were frequently told by Europeans of horses which died (while in the Gambia) with symptoms of disease.*

A glance at the names of the towns in which infected animals were found shews that, like human trypanosomiasis, the disease extends from the sea coast to the end of British territory. Judging from the scarcity of horses in the Kommbo district, and the larger percentage infected, one would imagine that it is there that the disease is most common. Nevertheless it seems improbable that it obtains in Bathurst itself.†

* Mr. A. K. Withers, a Travelling Commissioner, described to us a disease of which three horses out of twenty, owned at Quinela, had died during the month of December, 1902. His description very strongly suggests that these animals were suffering from trypanosomiasis.

† One of the two horses examined at the Bathurst Trading Company, coming originally from Barra Point, had lived for over twenty years at Bathurst, and had always been, and still is, in excellent condition. During all this time it had never been further away from Bathurst than Cape St. Mary. Bathurst is believed locally to be not unhealthy for horses.

We were also told while in Senegal, both by Government officials and traders, that in the Soudan, at Koli-chor and in the neighbourhood of Kaolakh, horses died from a disease producing symptoms closely resembling those observed in cases of equine trypanosomiasis in the Gambia.

While at St. Louis and Dakar we examined, with negative results, the blood of a few horses, mules, cattle, and camels which were not in the best of condition, and had been in districts where this disease was said to occur.

Horse, Case I, *October* 13, 1902

DISEASE.

Notes of Case

Name { Horse No. I.

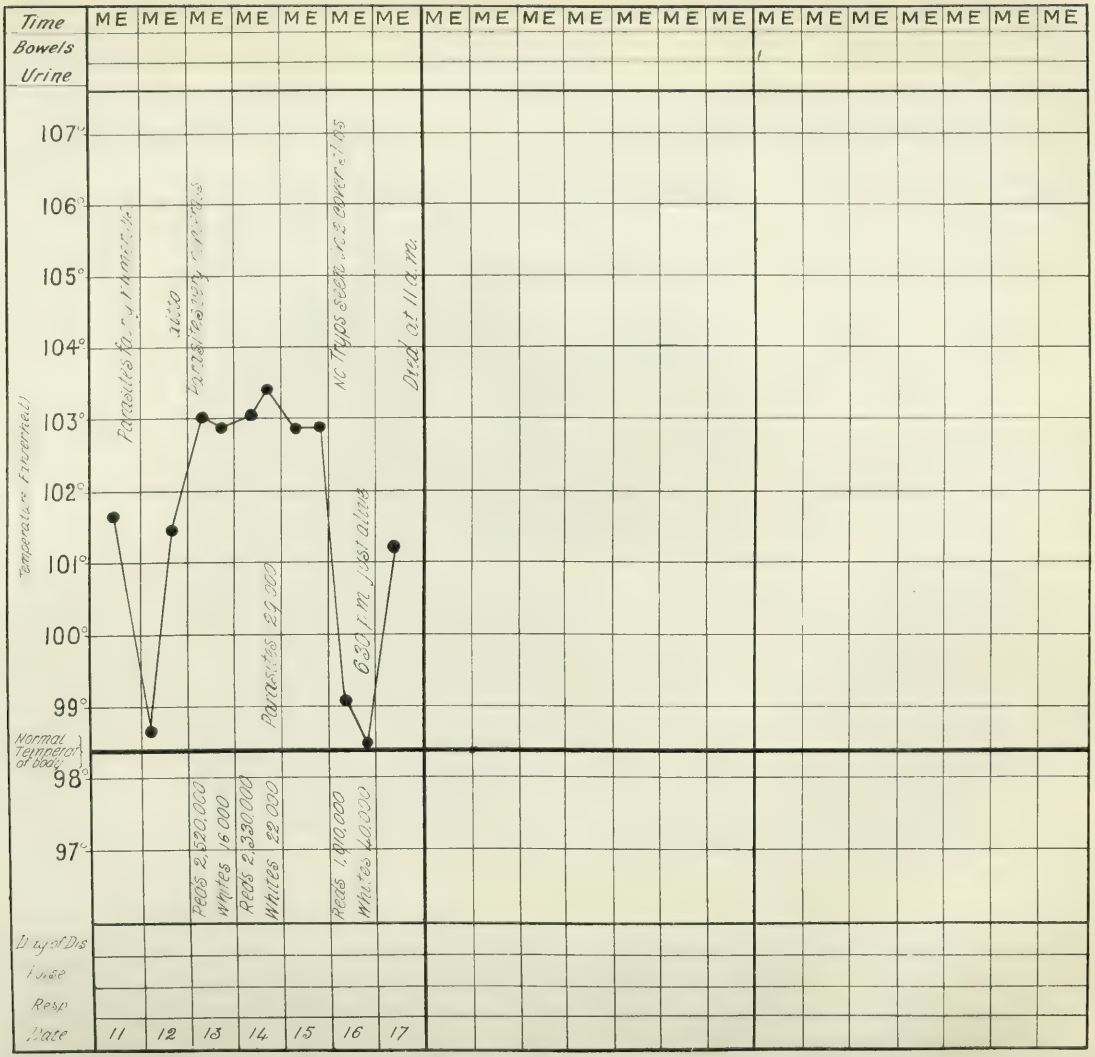
Age

Diet

Case Book No.

Date of admission
October 11th 1902

Result



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Cases of Equine Trypanosomiasis observed in the Gambia.

Case I.—Stallion, age about seven years, in charge of a native at Cape St. Mary.

History.—The origin of the horse was unknown. It had been in British Kommbo for about six months, and, according to the native who was in charge, it had been in the state in which we found it for only twenty days.

Clinical Examination.—When we first saw this horse it was *in extremis*, and it died six days later. We found a small dark-grey native stallion greatly emaciated and exhausted. He lay upon his side in the sun entirely apathetic to his surroundings. His skin was drenched with sweat and his breathing laboured and extremely frequent. Weakness was extreme, and it was not until after several attempts that the horse was able to stand. The loins and hind legs seemed weakest, it was their lack of strength which made the animal unable to rise. When at last the animal gained his feet he stood with legs apart and drooping head, a picture of utter weakness and inanition.

He was far too weak to protect himself from the swarms of flies hovering about him, and, as a consequence, his sheath and hide were dotted with 'bot fly' larvae holes. If the animal were forced to move, the hindquarters once more seemed to be weakest, they were not paralyzed but only paretic. We observed no oedemata, haemorrhages, or copious discharges from eyes or nostrils. Though the horse was ungroomed there was no 'staring' of the coat or loss of hair. The scrotum and sheath were relaxed. Mucous membranes and conjunctivae were anaemic, the latter were yellowish and showed no haemorrhages. The appetite was good and the animal fed and drank freely. It became progressively weaker, its temperature dropped, and it died on October 17 with markedly spasmodic movements almost amounting to convulsions. The temperature varied; it was usually about 103° F.

Blood.—The blood counts made showed a progressive diminution in the number of red cells, with a corresponding increase in white cells. A count made twenty-four hours before death gave only 1,910,000 red cells and 40,000 white cells. The number of parasites in this horse's blood three days before death was large, 2,900 per cubic mm., a day before death their numbers decreased to two parasites to a coverslip preparation.

The accompanying chart shows the temperature curve of this case during the short time it was under observation, and demonstrates in a striking manner an attack of fever associated with an increase in the number of parasites present in the peripheral circulation.

Autopsy.—Performed immediately. The coat was not staring. The mucous membranes were anaemic and rather yellow. On section, a yellowish gelatinous oedema of the subcutaneous connective tissue over the abdomen, particularly near the genitals and forehead, was noticed It was not present on the legs or thorax. It must be remembered that this oedema was sharply localized to the areas mentioned. It was not at all general and was not distinguishable ante-mortem. The muscles were rather firm, dark in colour, and not oedematous or cloudy. On opening the abdomen, the fat throughout was of a marked canary-yellow colour. The intestines were seen to be full of faeces. There was no peritonitis nor

peritoneal fluid. The unwounded intestines were thrown free of the body, and among their free coils, as well as in the peritoneal cavity, several free adult male and female filariae were found. (These were preserved for examination).

Thorax.—There was no pleurisy nor increase in pleural fluid. About two hundred c.c. of clear amber-coloured, quickly coagulating fluid was found in the pericardium. There were no signs of pericarditis.

Heart.—Weight, 1,360 gm. The connective tissue round the great vessels at the base of the heart was much infiltrated with a yellowish, quickly coagulating fluid, similar to that seen in the subcutaneous tissues: right side collapsed; left, full of blood. Valves, normal. Muscle, firm and rather dark; no ante-mortem clots. The organ contained no filariae.

The aorta was normal and contained no filariae.

An aneurism about the size of a walnut was situated on the superior mesenteric artery, 3·75 cm. from its origin. On being opened it was found to contain numerous sclerostomata. The walls of the aneurism were in many places partially broken down. Their thickness was about 1·9 cm.

Right Lung.—Weight, 810 gm., was dark throughout and contained many small pneumonic areas; it was everywhere congested. There was slight bronchitis. Vessels contained no clots.

Left Lung.—Weight, 1,113 gm. The colour of the lung was almost a canary yellow. It had not the appearance of acute degeneration. There was no pneumonia.

Abdomen.—There were no signs of peritonitis, neither were there petechiae, subperitoneal or mucosal.

Intestines.—The contents of the upper three-fourths of the canal were much bile stained. The large gut was filled with hard faeces. No intestinal parasites were seen.

Right Kidney.—Weight, 607 gm. Its colour was dark, but there were no haemorrhages. It was firm in consistency, and the capsule peeled with ease. Section shewed nothing abnormal.

Left Kidney.—Weight, 405 gm. Same appearance as right.

Suprarenals.—Seemed to be normal; there were no haemorrhages.

Spleen.—Weight, 810 gm. The substance was very dark and rather diffluent. The capsule slightly thickened, and the trabeculae well marked. They were particularly well seen after washing away the semi-fluid pulp. No infarcts.

Liver.—Weight, 3,645 gm. Everywhere over the capsule small, hard, yellowish nodules of about the size of a millet seed were seen. These were seen also throughout the substance of the liver; they seemed not to be calcareous, yet were too firm to be crushed between the thumb nails. The vessels were normal.

Pancreas.—Weight, 405 gm.; normal.

Lymphatic system.—Many of the mesenteric glands were enlarged to the size of a large walnut or pigeon's egg. These were seen on section to be soft, almost fluid in places, and yellow. They exuded a watery liquid strongly resembling the yellow fluid which has been described as infiltrating the connective tissues round the great vessels at the heart's base and the abdominal subcutaneous tissues. Other mesenteric glands were only slightly enlarged, many of them contained small haemorrhagic areas, principally in the cortex. Some of the pelvic glands were very dark in colour and uniformally haemorrhagic. Many small, markedly haemorrhagic glands were seen in the mesentery. On the left side, beneath the parietal peritoneum, was a large, dilated, turgid, lymphatic vessel, about 63 mm. in diameter. It was filled with pale yellow, easily coagulable fluid. It contained no adult filariae.

Brain and its membranes, particularly the pia mater, were congested.

Bone Marrow.—The marrow of the long bones was yellow in colour and apparently normal.

Coverslip preparations were made and examined from all the organs and from blood taken from different parts of the body. They were also made from the oedema fluid taken from the connective tissues, from the pericardial fluid, and from the

dilated abdominal lymphatics and glands. In none of them were any living trypanosomes found. Neither were parasites seen in the diluted vena cava blood which was used for injecting animals (successfully). Several c.c. of this diluted blood were centrifuged and examined, with negative results, for living trypanosomes.

Cases II *and* III.—Were both young stallions owned by natives of Bakau.

The previous history of neither was known. One had been in the village for only a year, the other longer. When seen, both were very thin, and one had a slight whitish discharge from the eyes. Temperature of each about 101° F. The blood of both horses contained trypanosomes (five to cover) similar in appearance to those seen in the remaining cases. The horse which had been in Bakau for only a year was said to have commenced to grow thin and weak in August, 1902. No oedemata, haemorrhages, discharges, nor marked paresis were seen in either of these horses. Mucous membranes were anaemic. Coats were glossy and not staring. One of these horses was living in May, 1903, the other died during December, 1902.

Case IV.—A stallion, two years old, owned by a native at Bakau.

History.—The horse was born in Bakau. Illness commenced a month previous to our examination on October 15. It had always previously been healthy. The mother of this colt had died of an illness which presented similar symptoms.

Clinical Examination.—The animal was very thin, ribs, ilia, and vertebrae being very prominent. There were no signs of oedema, nor of discharges from eyes or nostrils, of haemorrhages nor of paresis. The coat was glossy and smooth.

Temperature was 101.6° F.

A blood examination showed four trypanosomes to a coverslip preparation.

The emaciation continued, became extreme, and the horse died during the night of November 4. There was no autopsy.

Case V.—A young two-year-old stallion, bought from a native trader at Jesshuon (near Bakau), where the horse was born. It was first seen on October 19, 1902, when it was found to be infected with trypanosomes, two to a coverslip preparation. Temperature at this time was 103·4° F.

Clinical History.—The colt was small, and when first examined was in fairly good condition. Although thin, it was not emaciated, and was constantly ridden by its owner. Its appetite was excellent, but, in spite of a good supply of food, it became steadily thinner, and commenced to breathe rapidly and in a laboured manner even while at rest. Its coat was rough.

On November 28 it had become considerably thinner, and a scanty whitish mucoid discharge was noticed from eyes and nostrils. Emaciation and weakness progressed, and on December 18 the animal died suddenly. Towards the end of the disease, loss of power became a prominent symptom. The hind legs, particularly, were noticed to drag and to be weak.

The parasites in this case were never very numerous and were constantly absent for three weeks before death. The temperature was usually between 101° and 103° F. On two occasions, however, there were sudden rises to 106° F. Quantitative blood examination shewed a marked decrease of haemoglobin, on Nov. 27, thirty per cent., and a slighter decrease of erythrocytes; red cells, 4,700,000; white cells, 19,000; parasites, fairly numerous.

No oedemata nor yellowish tint of the anaemic conjunctivae and mucous membranes were ever noticed in this case.

Autopsy.—This animal died on December 8, 1902, and the *post-mortem* examination was commenced fifteen minutes after death. *Rigor mortis* had not set in. Body was much emaciated. Marked congestion of the conjunctivae and a few haemorrhagic points on the membrana nictitans and sclerotic. Mucous membranes, particularly of the gums, anaemic and of a slightly yellowish tinge. On section no yellowish oedema of the abdominal subcutaneous tissue, although there was some slight infiltration of a gelatinous straw-coloured fluid about the sheath of the rectus abdominis and about the penis. About 600 c.c. of straw-coloured liquid was taken from the peritoneal cavity. The lymphatic glands of the mesentery were boggy and permeated with a yellowish gelatinous, easily coagulable fluid, which oozed rapidly from them on section.

Spleen.—Weight, 506 gm. Slight thickness of the capsule together with an injection of its superficial vessels. On section the organ was dark in colour and slightly fibroid.

Right Kidney.—Weight, 354 gm. Normal.

Left Kidney.—Weight, 304 gm. Rather congested, otherwise normal; capsule of both peeled with ease.

Pancreas.—Weight, 202 gm. Normal.

Peritoneum.—Normal.

Thorax:—*Pleurae.*—Each contained about 100 c c. of clear straw-coloured fluid, in which were floating small coagula of lymph, here and there attached to the parietes, particularly towards the diaphragm; no pleuritis. The pericardium contained about 55 c.c. of similar fluid; no pericarditis. The bronchial glands were soft, oedematous, and soaked with the clear yellow fluid so often mentioned. Some of these glands were injected and others quite pale.

Right Lung.—Weight, 709 gm. The superficial vessels were congested.

Left Lung.—Weight, 607 gm.

Heart.—Weight, 1,113 gm. As in the first case, the connective tissue round its base was filled with yellow coagulated oedema fluid. The muscle was very pale and friable and somewhat mottled. All the valves were normal.

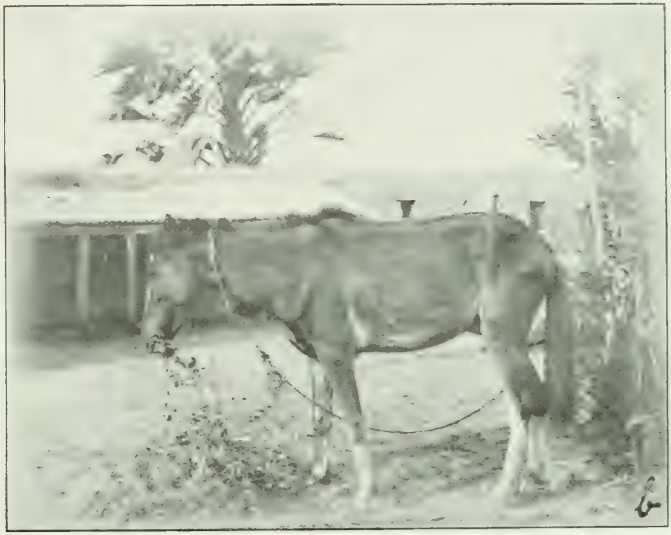
The *aorta* was normal. On the superior mesenteric artery there was an aneurism caused by sclerostoma similar to that seen in Case I.

The *alimentary canal* was normal; the intestines were not congested. A few bot-fly larvae were found in the stomach and also in the duodenum. The enlargement of the abdominal glands was not as marked as in Case I.

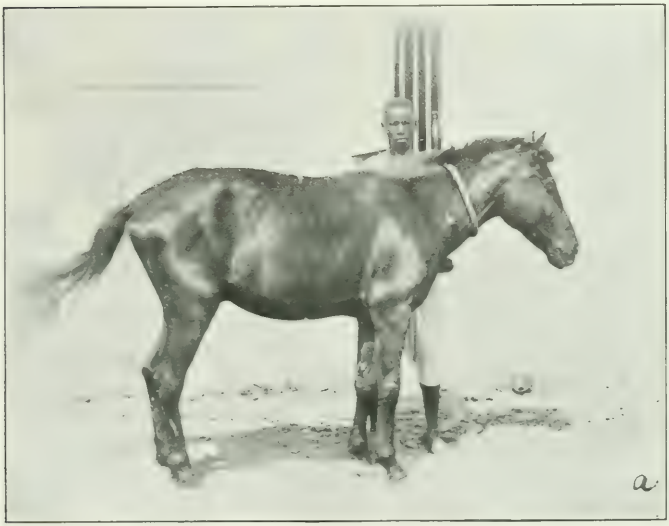
The marrow in all the bones, both long and short, was normal in appearance.

Films were made from all the organs. No parasites were seen in fresh preparations of blood taken from all the organs.

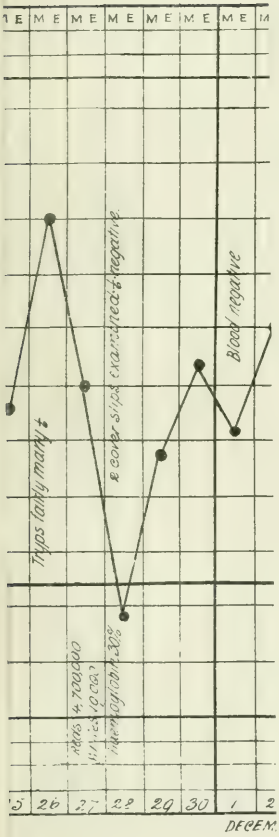
The accompanying chart of the morning and evening temperatures shows a fairly even temperature with rises at irregular intervals.



Horse, Case V, *November* 28, 1902



Horse, Case VI, *April*, 1903


ME ME ME ME ME ME ME M
Temperature
Pulse
Respiration
Urine
Stool
Weight
Blood Press.
Major daily events
25 26 27 28 29 30 1 2
DECEM.

DISEASE.

Notes of Case

Name | Horse V

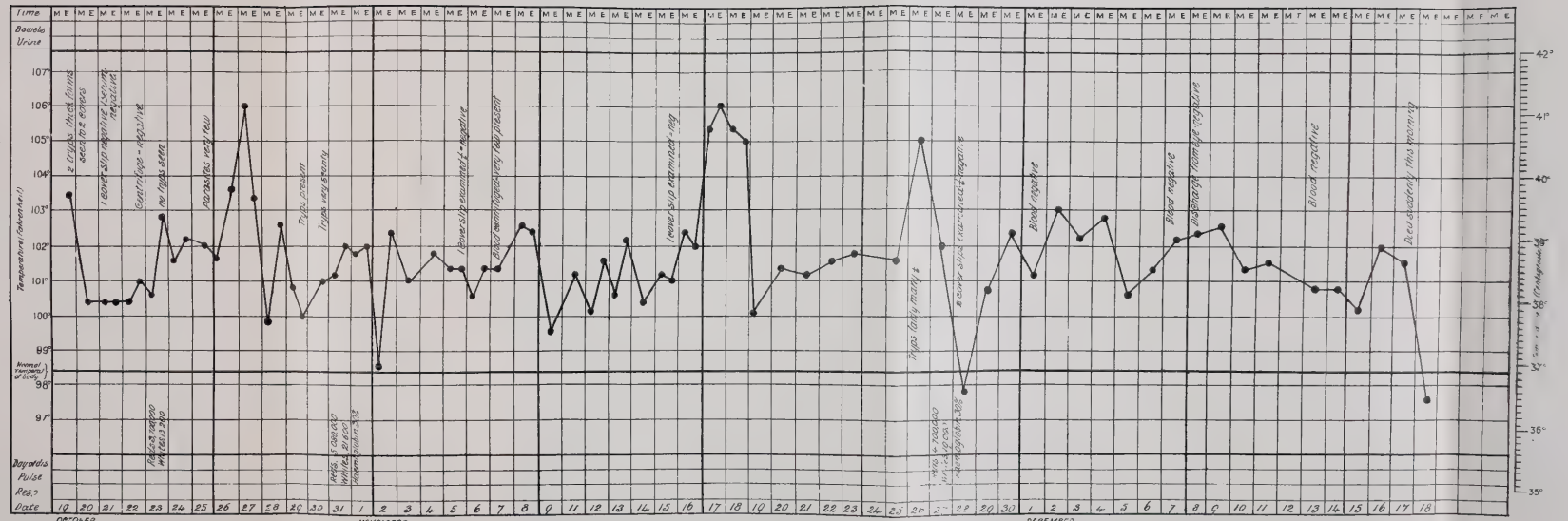
Age

Diet.

Case Book No.

Date of Admission October 19th 1902.

Result



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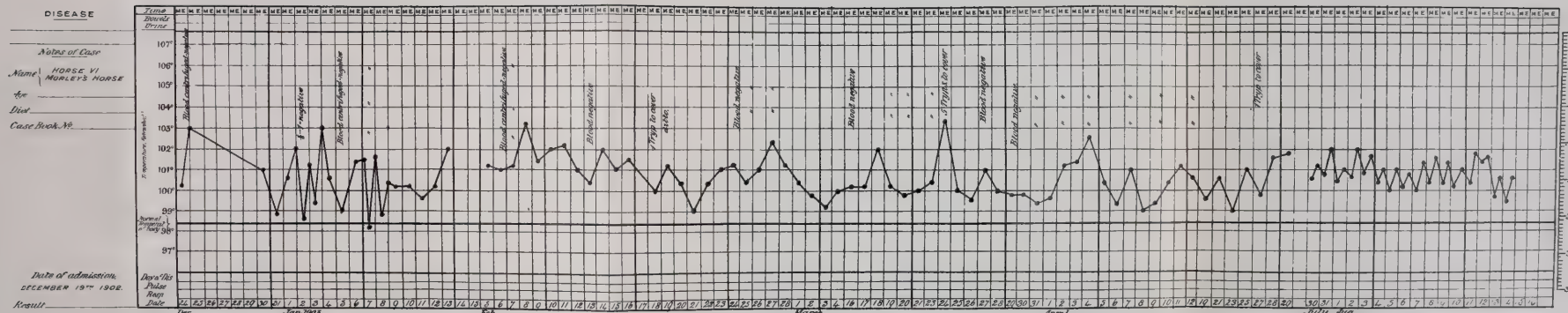

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Case VI. Small black stallion; age eight years. Owned by an officer of the West African Frontier Force.

History.—This horse has been in Bathurst for four years, and during this time has always been well. Of its previous history nothing was known. At the beginning of October, 1902, he was taken into foreign Kommbo, and on his return to Bathurst he had an attack of 'rheumatism' affecting his hind-quarters.

Clinical Examination.—He was examined on October 30, 1902, and found to be infected with trypanosomes. At this time he was sleek and in excellent condition. His owner stated, however, that the pony was not as vivacious as before the journey through Kommbo, and was not so hardy as he had been a year previously.

To one seeing the pony for the first time there was absolutely nothing to suggest ill-health. There were no oedemata, no listlessness, and no emaciation. There was no perceptible dragging of the hind legs or slackness in gait. The temperature varied, being usually about 102° F. Parasites were only periodically seen in the peripheral blood.

We have never observed any oedemata, haemorrhages, or paralysis in this horse. We have seen slight discharges from his eyes, but this was probably due to an intercurrent conjunctivitis. The genitals were relaxed, as is often the case, and conveyed the idea of enlargement without being really swollen.

Parasites were never very numerous in the blood of this horse and appeared periodically.

We purchased the animal towards the end of December, 1902, and have had it continuously under observation until the present date. The animal is still in apparently fair condition, and looks better than in March last when it was very thin and weak.

The temperature has been usually from 100° to 102° F., with periodic rises to 103° F., when parasites were often seen. The following chart gives the temperature curve of this case, and shows how frequently parasites were absent from the peripheral blood.

Urine was alkaline, Sp. gr., 1,042, and never contained albumen or blood. April 6.

Case VII.—Stallion, Joubert, aged eleven years, owned by French Government. Stationed at Maka.

*History.**—This horse came two years previously from Thiès. It had not been well for a year. 'Its feet, legs, and sheath had first become swollen.' This had been later followed by a fulness of the loins and by a general enlargement of the horse's belly.

When we saw this and the following case they were both apparently in excellent condition. We could detect no oedema, though the usual relaxation and apparent

* The histories of Cases VII and VIII, with the account of their illnesses was given to us by Monsieur Porthes. We take this opportunity of again thanking him for the aid which he gave us in our work.

enlargement of genitals was present. Their coats were smooth and glossy. There was no running from eyes or nostrils. Mucous membranes were rather pale. The appetite in each case was good. Their abdomens were rather distended. These animals were not grass fed. Temperature of Case VII, 100° to 101° F. Number of parasites, one to a coverslip preparation.

Case VIII.—Stallion, Jourdan, eight years old: it came two years previously from Thiès.

History.—This horse was taken ill at the same time as Case VII. The symptoms were the same in both cases. The animal had not been worked for some time when we saw it, and was in much better condition than Case VII.

The clinical examination has already been given. Temperature was 101° to 101·5° F. Trypanosomes were very scanty, one to a coverslip preparation, and were seen on but one occasion.

M. Porthes recognized the illness from which these two horses were suffering. He believed that they acquired it while in Tenda, where forage is poor and water is scanty. He ascribed the first symptoms which he noticed, weakness and swelling of the cannons, to the poor food, and hard usage over stony ground which horses get while travelling in that district. He had seen other horses suffering from a similar affection, and described in them a fulness of the loins which alternated with distension of the abdomen and swelling of the sheath and scrotum. He described an accompanying anorexia, and stated that the course of the illness may vary, death following after a week or two to several months. Sometimes, indeed, animals may recover. He has never observed running from eyes or nose, haemorrhages from any part, or marked oedema in any of these cases. He had seen staring of the coat in some cases, never depilation. He had never seen the disease in an epidemic form.

Case IX.—A grey stallion, five years old.

The origin of the horse was not known. It had been owned for fifteen months by the officer who had it when we first saw it. Two years and a half previous to this time the horse became extremely emaciated and weak. It was expected to die, but recovered its strength after a prolonged rest. In July, 1902, it had lampus badly and became very thin. When the mouth was cured and the animal once more commenced to eat heartily, it rapidly regained the weight lost through lack of food. In January, 1903, the horse was taken on a tour through the country on the north bank of the Upper River, and, although it had lots of hard work, returned to the Lower River in apparently excellent health.

Clinical History.—When the animal was seen in April, 1903, its owner stated that a month and a half previously he had noticed that it was rather 'slack' and 'coughed' at night.' It had since lost flesh, 'particularly about the chest,' and the abdomen had become 'bigger.' The horse stood with hanging head, in the same listless way as was noticed in the preceding cases. The scrotum and penis were

relaxed and apparently swollen, though neither about the genitals nor in any other part of the body could oedema be demonstrated. The temperature varied from 101·6° to 104·2° F. Trypanosomes were seen in the blood on two occasions during the two days the pony was under observation.

Case X.—A bay stallion belonging to the Governor of the Gambia. This was also a very early case. For only a few weeks had it been noticed that he was not as lively as usual. Parasites were demonstrated in his blood on two occasions. The symptoms were precisely those noted in the early stages of the preceding cases, save that there was very little loss of flesh. Temperature varied from 100° to 102° F. during the short time the animal was under observation. This case is the only one of this series in which treatment has been attempted. Liquor arsenicalis was used in gradually increasing doses until the horse was getting five grains of arsenic a day. The dose was kept at this for a week and then reduced. Sir George Denton, in a letter dated June 23, says that the horse is 'decidedly better.'

With the aid of these cases we can construct a well-connected though composite picture of what we believe to be the usual course of the horse disease in Gambia and the immediately adjacent territories. Three of these cases were seen in the earliest stages of the disease, two during their last weeks, and the remainder at various periods during the course of their illness. One case we have had under continual observation since it was first noticed to be 'off colour,' and within a month of the date at which it was supposed to have been exposed to infection.

Sketch of Symptoms.—The first feature noticed is loss of accustomed vigour. There is not quite the same vivacity in harness nor usual power of much endurance. Still, the animal is apparently in perfect condition. He is fat and his coat is smooth. The temperature is only slightly above normal at this time (102·6° F,), and if the blood be examined but few parasites will be seen, perhaps as many as ten to a cover, often not so many. Even these may, for long periods together, be absent from the peripheral blood.

Two or three weeks later more marked signs of ill-health become manifest. The horse has commenced to grow thinner, his head is drooping, his eye is not so bright, and although he is well able to go under saddle, still the rider is conscious of the animal's weakness, which has now become patent.

At this period there are periodical rises of temperature, at which times the parasites will usually be found in the blood, although they may often be absent.

In another month emaciation is more marked. The ribs commence to shew. As a Frontier Force Officer pithily expressed it, 'the flesh seems to slip back from the horse's chest to his belly.' Although the abdomen becomes large it is not in any sense due to an oedema. We never observed pitting, and believe that the apparent enlargement is due rather to the atonicity which affects the muscles of the bowel in common with those of the trunk. The scrotum becomes relaxed and the testicles hang so

low that they seem at first sight to be oedematous. At times a slight watery discharge from the eyes may be observed. In none of the horses have we observed the marked oedema of abdomen, scrotum, and legs, nor the staring of the coat which is described in horses suffering from Nagana.

This last stage has lasted in one of our horses (Case VI) for ten months, and during this time on only four occasions have parasites been seen in his blood. On each occasion their presence was accompanied by a slight rise in temperature to 103° F., or thereabouts.

As the disease proceeds, emaciation becomes more and more marked. The ribs and ilia stand out prominently. The animal wears an apathetic chronically-tired expression which is most characteristic. No oedema is to be made out. A whitish discharge from the eyes, in small quantities, is often seen. Saddle galls and sores on the projecting hip bones are often present. No haemorrhage has been observed in any of the mucous membranes. No blood has been seen in the urine.

The parasites are now often almost continuously present in the blood and may reach very considerable numbers. Case V, however, presents a most notable contradiction to this generalization.

The temperature fluctuates, though it is generally raised, and may go up as high as 105° F.

Two horses have died under observation. One lingered for three days, scarcely able to rise from the ground, in a state of utter weakness. His breathing was very laboured, he sweated almostly continuously, and just before death had a slight convulsive seizure (Case I).

The second animal died suddenly one day after being taken out a little distance to graze. In this animal a few conjunctival petechial haemorrhages were seen (Case V).

The most notable features observed in the autopsies of these two animals were the yellow gelatinous oedema fluid found round the sheath, and in the first case, on the abdomen, and the amber-coloured fluid with flakes of yellow gelatinous lymph seen in the peritoneum and in the pericardial and pleural cavities. There was a general enlargement of all lymphatic glands. Some were soft, amber-coloured, and watery, others had a chocolate-coloured centre, and still others shewed marked petechial haemorrhages ; some were entirely haemorrhagic. Spleen was not enlarged. Lungs were congested. Liver shewed fatty change. In one case the heart shewed marked fatty degeneration (thrush heart). To the naked eye there was no change in the bone marrow.

Only in the very last stages of the disease does any marked alteration in the blood seem to take place, then both red cells and haemoglobin are diminished.

Duration of Disease.—How long the disease lasts we cannot at all say. We have now (November, 1903) under observation, a horse (Case VI) which we bought in November, 1902, in good condition (first stage). We believe that it contracted the disease at least a month before.

Just before leaving Bathurst we heard that a year-old colt examined and found to be infected in October last, was still alive. On the other hand, a similar young horse (Case V) in much the same condition, which was seen at the same time, died two months later.

Prognosis.—We think from what we have seen that it is not impossible that horses may occasionally recover.

The Diagnosis of Horse Trypanosomiasis.—Although a positive diagnosis of trypanosomiasis can only be made by a demonstration of the parasite, either by microscopical examination of suspected blood or by inoculation of that blood into experimental animals, we were in several cases enabled to diagnose the disease by the listless expression of the affected animal, and by the slight rise in temperature, which was always present. So constant is this latter symptom, that we came to regard with the greatest suspicion as a possible case of trypanosomiasis any horse whose temperature was over 101° F.

IV. MORPHOLOGICAL CHARACTERISTICS OF THE HUMAN AND HORSE TRYPANOSOME FOUND IN THE GAMBIA

We propose to give here short descriptions of the microscopical appearances of the human and horse trypanosomes as they are seen in the peripheral blood of their respective hosts and in experimentally infected tame rats.

We reserve a more detailed account of these parasites and a description of their appearances in various other animals inoculated for a future report.

The description of the morphological characteristics of a pathogenic trypanosome presents at the outset great difficulties; so varied are the forms seen, so minute are the differences distinguishing one form from another, and so many are the intermediate stages between two contrasted forms in any infected animal, that it requires some time and study before the characteristic adult form of parasite can be finally determined.

Though we could detect no constant morphological differences between the human and the horse parasite—more especially was this the case in inoculated animals—still the parasites usually seen in the blood of horses, examined in the early stage of their infection, presented marked differences in size and appearance from the parasite usually seen in the blood of the infected natives.

The Human Trypanosome.—Plate I, fig. 1, represents this parasite as usually seen in the native.

In stained preparations its length, including the flagellum, averages 20 μ. Its width is 1·8 μ to 2 μ. The distance from micronucleus to the centre of the macronucleus is 5·9 μ. The distance from the micronucleus to the tip of the posterior end of the body was found to vary, as a rule it measured 1·6 μ, but parasites were often seen in which this distance was only 0·5 μ.

This trypanosome, as seen in the native and quadroon cases, presented no features morphologically differentiating it from the one described by one of us in 1901, as occuring in the blood of a European and a native child in Gambia, and named *T. gambiense.*

The Horse Trypanosome.—The parasite seen in Senegambian horses was never encountered in any great numbers in the peripheral blood during the early stages of the infection. The blood of one horse, Case V, in which the disease proved fatal, never contained many parasites.

Plate I, fig. 6, represents the trypanosome as seen in the early stages of infection of the horse. The parasite is a very small organism, rather tadpole-shaped.

Its protoplasm stains deeply. Its posterior end is either sharply cut away or bluntly conical. The body tapers from the posterior end as a rule, and is prolonged anteriorly into a short fine flagellum.

The micronucleus and vacuole are placed almost at the extreme posterior end of the parasite, the former is a small dark crimson staining spot generally situated to one side, the latter varies much in size in different specimens. The macronucleus is generally rounded, granular, and does not quite extend across the short axis of the body. The blue staining body-protoplasm of some specimens contains a few isolated chromatic granules. The undulating membrane is narrow and is seen with difficulty in stained preparations.

The measurement of this type of parasite in stained preparations is as follows :—

Length, including flagellum, 11 μ to 13μ. Width, 0·8 μ to 1 μ. Distance from micronucleus to centre of macronucleus, 4 μ to 6 μ. Distance from micronucleus to posterior end of body, 0·3 μ to 0·5 μ. Divisional forms of this small parasite are represented in Plate I, fig. 8.

In horses in the last stage of the disease and in rats inoculated with either the human or horse trypanosome, we were generally able to distinguish roughly two constant types of parasite. These types we called for convenience the 'long form' and the 'stumpy form' of the parasite.

A.—The long form (Plate I, figs. 9 and 10) is characterised by a long thin body and a long flagellum. The posterior end of the parasite may be long (pointed or square shaped) or stumpy and conical. The deeply staining macronucleus is ovoid in shape and lies longitudinally. It is this type of parasite that multiplies by longitudinal division. The length of such a parasite, including the flagellum, is from 26 μ to 30 μ; width, 1·6 μ to 2 μ. Distance from micronucleus to centre of macronucleus, 7 μ to 8 μ. Distance from micronucleus to posterior end of body, 1·6 μ to 3·2 μ.

This type can be recognized in fresh blood by its rapid movements and long flagellum, and is usually most numerous in the blood of an infected animal a few days before its death.

B.—The Stumpy form (Plate I, Fig. 7).

This type of parasite is more commonly seen in the blood when the disease in an infected animal is not far advanced. It is characterized by a short thick body and very short flagellum. The posterior end is short and conical, and generally quite close to the tip is situated the micronucleus and vacuole, the latter as a rule is well marked.

The macronucleus is either oval or circular in shape. If it is ovoid it is placed transversely in the body of the parasite. A few scattered chromatic granules may be seen in some specimens.

Longitudinal division of this type of parasite has not been observed.

Measurements in stained preparations: length varies from 16 μ to 19 μ; width from 3·4 μ to 3·5 μ. Distance from micronucleus to centre of macronucleus, 5 μ to 7 μ. This type of parasite generally survives for a longer time in ordinary fresh preparations than the long form.

Though the above broadly divided types of parasite can be distinguished at a glance in stained preparations, yet in slides containing many trypanosomes one observes every gradation between the stumpy and the long forms, and between the stumpy type and a rounded form (Plate I, Fig. 5), which we have seen in the blood of horses and rats in the last stages of the disease, produced by infection with either the human or horse parasite.

The Human Parasite in Rats.—The parasite when first seen in the peripheral blood varies little in appearance from the usual type of parasite seen in the native, and, as in the native, few are seen in a preparation. Long and stumpy forms and longitudinally dividing parasites (Plate I, Fig. 3) are occasionally met with.

The long forms are generally slightly smaller than those seen in rats infected with the horse parasite, and their macronucleus is situated slightly more towards the flagellum-bearing end of the parasite. Compare Plate I, Figs. 2 and 10. A few of the parasites shew chromatic granules in the protoplasm in front of the macronucleus.

The appearance of the parasites differs to some extent from the above type in preparations which were taken, two or three weeks before death, from two rats which have died (Experiments LXIX and XXVII). The parasites are more numerous, and more long forms undergoing division are seen. In nearly all the parasites there is a marked chromatic stippling, produced by chromatic granules situated in the protoplasm, posterior as well as anterior to the macronucleus. The number of these granules varies greatly. In the parasites undergoing longitudinal division, generally few or none occur. In some of the parasites the chromatic granules are very large. They take on a deep blue purple colour with Romanowsky's stain which, though closely resembling the chromatic staining of the micro- and macronuclei, can be distinguished from it by its bluish tinge (Plate I, Figs. 2, 4, 5).

Besides the above types there are seen in rats, at this late stage of the disease, rounded forms (Plate I, Fig. 5). In them the macronucleus is round and, usually, the individual chromatin granules composing it can be made out. The macronucleus is situated either in the centre of the parasite or to one side. It does not occupy the whole width of the body. In forms more completely rounded than represented in Fig. V the posterior and anterior ends of the body cannot be made out, and the flagellum is often only attached to the parasite for a short distance. Some of these forms show two or more macro- and micronuclei. These probably correspond to Plimmer and Bradford's 'amoeboid forms.'

The Horse Parasite in Rats.—The parasites seen in the blood of rats infected

from Horse I were, from the commencement of the infection, precisely similar in appearance to those occuring in that horse. Stumpy forms were at first more frequently met with in these rats, but as the parasites increased in the blood more long and dividing forms were seen. About a week before death amoeboid forms were also seen in the peripheral blood of these rats. Chromatic stippling was only occasionally seen in the parasites.

The parasites which first appear in the blood of rats and mice inoculated from horses in an early stage of the disease are morphologically identical with the small forms seen in the horse (Plate I, Fig. 6). Many of these small forms are seen in all stages of longitudinal division (Plate I, Fig. 8). As the disease in the experimental animal progressed, long and stumpy forms were seen, and the smaller tadpole-shaped parasites tended to disappear. Rounded forms can be seen in the blood of many rats in a late stage of the disease.

Still another variety of parasite has been seen occasionally in the peripheral blood of rats inoculated with the horse trypanosome and also in the blood of horses either one, two, or three days before death.

In shape, like either the stumpy or long form, it differs from them by its very feebly staining protoplasm. This type corresponds very closely to the 'hyaline' forms described by Plimmer and Bradford.

V. TRANSMISSION EXPERIMENTS

A tsetse fly, *Glossina palpalis*, is practically ubiquitous in the Gambia. It is particularly numerous among the mangrove swamps, and for this reason it is locally called a mangrove fly. It is, however, seen all along the river, far above the brackish water in which the mangroves grow. Though the flies, as a rule, seem to prefer the immediate neighbourhood of some large expanse of water, they have been seen and caught in the bush at some distance (two miles) from any collection of water. We have taken specimens just outside Bathurst, everywhere through British Kommbo, and at many places along the river as far as Sunkunda. They were seen at Walia, and everywhere on the river itself they were a most pertinacious and disagreeable pest.*

It was with this fly naturally that we made our first attempts to transmit trypanosomiasis from infected to healthy animals.

We first allowed flies caught in British Kommbo, where there was a good deal of equine trypanosomiasis, to feed upon healthy rats. Our results were always negative.

A detailed account of these experiments follows :—

Experiment 1.—A white rat was selected, and tsetse flies caught in the bush near Bakau were fed upon it in the following manner and on the following dates :—

Sept. 14, 1902—4 flies out of a batch of 6 fed.
" 15 " 3 " " "
" 15 " 4 of the flies caught on the fourteenth also fed.
" 16 " a batch of 6 fed.
" 17 " 3 flies caught on previous dates fed.
" 18 " a batch of 4 fed.
" 19 " 2 flies caught on previous dates fed.
" 23 " 4 flies out of a batch of 17 fed.
" 24 " 3 freshly caught flies fed.
Oct. 1 " 3 " " "
" 3 " 8 " " "

Altogether, 44 flies (*Glossina palpalis*) caught from the bush at Oyster Creek, about three and a half miles from Bathurst, were fed on this rat at periods varying from

[illegible] never succeeded [illegible] in Senegal. Not [illegible] flies were seen in the mangrove swamps in the neighbourhood of St. Louis, which, in the Gambia, would certainly have sheltered myriads of them.

Traders and residents in St. Louis and Dakar failed to recognize the specimens of *Glossina* which were shewn to them, and officers on steamers plying on the river Senegal, between St. Louis and Kayes, had never seen the fly. We were, however, told that it occurred to the South, on the River Kaolakh.

The absence of *Glossina* from a district in which we failed to find equine trypanosomiasis forms, perhaps, a striking [illegible] fact.

one to twelve hours after their capture. Only those flies which were seen to be gorged with blood were held to have fed. It may be assumed that all the flies which were given an opportunity to feed attempted to do so, and that the proboscis of a much larger number of tsetses than 44 pierced the rat's skin. The blood of this rat was examined constantly, always without success, for trypanosomes.

Experiment 1a.—Tsetse flies caught near Bakau, where five out of the six horses owned in the native village were infected with trypanosomes, were allowed to feed at once on an uninfected white rat.

Oct. 24—25 newly-caught flies fed well.
,, 25 10 ,, ,, ,,
,, 26 2 ,, ,, ,,
,, 28 2 ,, ,, ,,
Nov. 14—30 ,, ,, ,,

This rat was constantly examined, always with negative results, until April 14, 1903, when it died from sunstroke.

Experiment XIX.—Flies freshly caught near Bakau were allowed to feed upon a young non-infected white rat.

Oct. 24— 2 flies fed.
,, 25—10 ,, ,,
,, 26—10 ,, ,,
,, 28 20 ,, ,,
,, 29 8 ,, ,,
,, 30 12 ,, ,,

This rat was constantly examined without result until November 14, when it was killed.

Experiment VIII.—We also attempted to infect a tame rat by allowing it to be bitten by tsetse flies which had previously fed on a naturally infected horse (Case No I) and on an artificially infected rat (Experiment IX) in the blood of which there were a great many parasites.

A stock of flies, continually replenished by the addition of freshly-caught flies, was kept in a cage and fed on successive days alternately on the infected and non-infected animals in the following manner :—

Infected Animals	Uninfected Rat
Oct. 11—12 flies put to feed	Oct. 12—5 flies fed well at 9 a.m.
4 filled themselves	
,, 12— 6 flies fed on Horse I at 4 p.m.	,, 15—3 out of 6 flies fed, others attempted to feed at 9 a.m.
Horse died	

Infected Animals—*contd.*	Uninfected Rat—*contd.*
Oct. 21—5 flies fed on rat. Experiment IX, 3 at 1 p.m., 2 at 6 p.m., many trypanosomes in blood.	Oct. 16—5 flies fed well.
„ 22—5 flies fed on Experiment IX	
„ 24—25 flies fed on Experiment IX this p.m.	„ 25—Many of 25 flies pierced the skin, but none succeeded in getting full meal.
„ 26—2 flies fed on Experiment IX	
„ 29—6 flies fed on Experiment IX	„ 30—All flies fed on rat.

The conditions of this experiment were purposely made as broad as possible. The sole object of the experiment was to see whether *Glossina palpalis* would transmit the Gambian horse trypanosome in the same way as *Glossina morsitans* does Trypanosoma brucei.

With this end in view, flies which had fed at any previous period on either of the infected animals were allowed to feed indiscriminately on the test animal. This was examined constantly until April 14, when it was killed by sunstroke. Its blood was, as in all the transmission experiments, examined, at first, daily, both with and without the centrifuge, and always in vain. The autopsy revealed nothing abnormal.

Although tsetse flies could be found near McCarthy Island, where we made our headquarters from January to April, it was never possible to catch them in sufficient numbers to make the success of a repetition of these experiments probable.

It is maintained that the tsetse fly carries Nagana from animal to animal in a mechanical way, and that probably no biological change in the parasite intervenes. We, therefore, determined to repeat these experiments, using instead of *Glossina*, two varieties of *Stomoxys* (not yet identified), which were very plentiful in the Upper River, and easily caught.

Experiment CI.—During a period of eight days, a number of *Stomoxys*, about one hundred altogether, were caught from two horses and placed in the same cage. One of these horses (Horse No. VI) was a naturally infected animal, and at this time its blood contained on an average five parasites to a preparation. The other (Experiment LXXXVII) was a young native stallion which had been artifically infected with the human parasite from rat LXIX (Q. strain). The flies had an opportunity of feeding within twenty-four hours of the time at which they were caught, on a young, non-infected white rat, aand they were allowed to feed daily on the same animal for a period of eight days. The rat has been under observation up to the present date and has never become infected.

Experiment C.—On March 18, 1902, a large number of *Stomoxys* were caught while feeding on a horse (Experiment LXXXVII) infected with the human trypanosome. They were daily fed upon this horse, whose blood contained five parasites to a preparation until March 24. On March 25 they were allowed to bite a young non-infected white rat. Twenty-four flies fed well.

The flies were then fed on alternate days on the horse and test rat as follows :—

March	26	Flies fed on	Horse LXXXVII.	Many fed.	
,,	27	,,	,, Rat.	,,	
,,	28	,,	,, Horse LXXXVII.		
,,	29	,,	,, Rat.		
,,	30	,,	,, Horse LXXXVII.		
,,	31	,,	,, Rat.		
April	1	,,	,, Horse LXXXVII.	Very few fed.	
,,	2	,,	,, Rat.	Only one sucked blood.	
,,	3	,,	,, Rat.	None fed.	
,,	4	Flies were not fed.			
,,	5	,,	,, ,,	Many dead.	
,,	6	,,	,, ,,	All dead.	

This rat has been under constant observation, and up to the present no trypanosomes have been demonstrated in its blood.

Experiment CVI.—Flies were caught from the same horses as in Experiment CI. They were placed together in a cage and allowed to feed upon Rat Experiment LXVIII, in whose blood there were at this time numerous 'horse trypansomes' (derived originally from Horse I) ; twelve hours later they were allowed to feed upon a non-infected white rat. This was done on two occasions. Thirty-five flies were observed to feed well upon the non-infected animal.

The experiment was commenced on April 3, and, up to the present, parasites have never been seen in the rat's blood.

If the natural mode of transmission of the Gambian trypanosomes is a simple mechanical transference of the parasite from an infected animal to a healthy one, which is infected by the prick of a proboscis containing parasites, it seems strange that our experiments should have always been unsuccessful, and our efforts to repeat Bruce's transmission experiments without result.

As has been previously said, if the parasite is transmitted in a purely mechanical manner, it seems probable that other insects, possessing biting parts similar to those of *Glossina*, should also be carriers of the disease.*

* Mr. E. E. Austen, dipterist to the British Museum, who is classifying and describing the biting-flies collected by the expedition in Senegambia, informs us that our collection contains five species of *tabanus*, one species of *glossina* (*palpalis*), two of *stomoxys*, and one of *hyperoscia*.

In Senegal, *hippoboscidae* were very frequently seen, and at St. Louis we caught several blood-sucking flies which belong to a new genus near *Musca*.

Heads and probosces of the tsetse flies and *stomoxys* used in these experiments were frequently dissected. In none of them were trypanosomes, as they are observed in the blood, ever seen. The head parts of insects were examined *immediately* after they had fed upon animals in whose blood the parasites were exceedingly numerous, and never were they found to contain recognizable trypanosomes either living or dead.

Living actively motile parasites, not in the least degenerated, were, however, seen in the stomachs of these flies for many hours after their ingestion. Their peculiarities and the alterations which they later underwent will be considered in a further report.

Our fly experiments were done during the dry season. It is possible that they failed owing to the excessive lack of moisture which could not fail to have made it impossible for the parasites to live, for even a few hours, in the insect's proboscis.*

An observation, interesting in this connection and based upon a very careful diary, has been related to us by Mr. Hewby, F.R.G.S., formerly a resident in Northern Nigeria.

There is on the north bank of the river Benue (Nigeria), opposite Ibi, a notorious tsetse fly belt where *Glossina* occurs and in which horses contract 'tsetse fly' disease.

Mr. Hewby unhesitatingly picked out specimens of *Glossina palpalis* from our collections, and assured us that the tsetse fly of Ibi was practically identical with them. The symptoms and duration—three to (rarely) ten weeks—of the disease in horses (it also affects cattle) convinced us that what is called tsetse fly disease in Northern Nigeria is most probably Nagana.

On two occasions (1899-1900) all the horses sent by Mr. Hewby and others through this particular 'belt' during the rainy season contracted 'fly disease' and died.

Twice during the dry season (1901-1902), although the tsetse flies—seen also during the wet season—were extremely numerous, have ponies gone through the same belt of fly-bush without suffering harm. Once a pony taken in the dry season (May 1902) through a bit of bush comparatively near the Ibi belt 'was covered for hours' with the fly and yet did not contract the disease.

Mr. Hewby also informed us that, as in the Gambia, the neighbourhood of the river is believed in Nigeria to be unhealthy for cattle and horses during the rains. It is in addition generally believed that the fly is practically harmless during the dry season. It is interesting to note that Mr. Hewby knows of no instance in which asses and sheep have suffered from 'fly-disease.'

* At McCarthy Island, during the period at which our *Stomoxys* experiments were done, the dry thermometer in our laboratory daily registered about 95° F., the wet bulb thermometer being usually from 15° to 20° lower.

Though the conditions were similar during the tsetse fly experiments done at Cape St. Mary the temperature was not so high nor was the daily difference between the wet and dry bulb thermometers so great.

VI. RESULTS OF INOCULATION OF THE GAMBIAN HUMAN AND EQUINE TRYPANOSOMES IN EXPERIMENTAL ANIMALS

Inoculation Experiments

The experiments have been divided into two sets of tables, Human Trypanosome and Equine Trypanosome. In these divisions all the inoculated animals of the same species have been arranged according to the passage of the parasite and, as far as possible, all those of the same strain have been grouped together. In every case the strain of the parasite inoculated has been noted. In all the inoculations the blood was mixed with sterile sodium citrate solution (page 2).

All the rats and mice used in the following experiments were tame ones with the exception of a few bush rats and some wild mice—in the tables these animals are specifically marked.

All the animals were carefully and repeatedly examined before inoculation, to ascertain if they were free from Trypanosomes.

Résumé of Inoculation Experiments

We think that it would be premature and unprofitable to enter upon a detailed discussion of the properties and identities of these two Gambian Trypanosomes, based upon the experiments which we present in this report.

We fully recognize the importance of determining whether these two parasites are the same, or whether either is identical with any previously described pathogenic Trypanosome. At present we are inclined to believe that they are not the same species ; our reasons for this opinion are :—

1. The more chronic course of the disease produced by the human parasite in all animals, perhaps with the exception of the goat.
2. Tame rats infected with the horse parasite certainly die from its effects, while, on the other hand, we have no evidence to show that the infection which has occurred in tame rats, inoculated with the human parasite, has been the only cause of death.
3. The modes in which the human and horse parasites appear and disappear in the blood of inoculated animals, during the course of the disease, is not the same ; thus, in rats inoculated with the former parasite, there is a marked periodicity of entrance and exit of the parasite in the peripheral circulation, in the case of the horse parasite this periodicity is not a marked feature.

4. In most animals the enlargement of the spleen and the presence of haemorrhagic glands is a characteristic feature of infection with the horse parasite. In the case of the human disease, in the few rats that have died infected, the autopsies of these animals have not shewn haemorrhagic, nor even markedly enlarged glands.* On the other hand, we must remember that we have infected one horse with the human parasite, and it has produced a disease in that animal clinically indistinguishable from that seen in naturally infected horses. We know also that baboons (*cynocephalus sphinx*) have, up to the present, been insusceptible to both parasites.

5. We have already mentioned that the parasite found in horses, in the early stage of the disease, can be distinguished by its morphological characteristics from the human trypanosome found in the native.

The possibility of inoculating some of our animals now immune to the horse parasite with the human trypanosome, and other experiments of a like nature already in progress, will probably throw considerable light upon what we judge to be the most urgent problem requiring solution, namely, the identity or otherwise of these two parasites.

* In the case of a goat and a guinea-pig inoculated with the human parasite, haemorrhagic glands were seen at the post-mortem.

EQUINE TRYPANOSOME

INOCULATIONS IN RATS

FIRST PASSAGE

Animal	Date, Source and Mode of Inoculation	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites usually seen in preparations	Type of Temperature records	Result Date of Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. IX Small black and white rat ♂	September 27 Mr. Q Intraperitoneally with 1 drop of blood. Examined daily from second day after inoculation. Parasites found in blood on 3rd day.	Not seen			October 15 Died			Tissue very juicy, no enlargement of the spleen	
Exp. IX B Large white rat ♂	October 12 Horse I Intraperitoneally with 1 c.c. of blood.	October 15 Only few seen to develop. Died a week later	Never gained numbers above 1 in F	Temperature never above 101 F.	November 1 Duration, twenty days		Exp XVII Exp XVIII Exp XX Exp XXI Exp XXII	All emphysematous, much enlarged, some haemorrhagic, spleen much enlarged and dark	
Exp. XIV Large white rat ♂	October 24 Horse I Intraperitoneally with 1 c.c. of blood. Examined daily from second day after inoculation. Parasites found in blood on 3rd day. Mosquitoes used in preparations	November 24 Mosquitoes proved unsatisfactory	On November 1 parasites were found on forehead, on November 2 on conjunctiva, on November 4 on abdominal skin. Parasites found in blood on 3rd day.	Normal between 100 F. and 101 F., one temperature of 102 F.	November 18 Duration, twenty-five days	Rapid increase in red cells from 5,000,000 to 6,000,000		Tunica vaginalis distended with sero-sanguineous effusion. Both testes much congested. Spleen, 8½ × 4½ × 2 cm.	
Exp. XV Black and white rat ♂	October 25 Same as in Exp. XIV	October 28 Few parasites, very scanty	Scarcely any seen on 28th, 29th and 30th, 10 to 15 on 31st	Varied between 100 F. and 101 F., one of 102 F.	November 11 Duration, twelve days	Same as in Exp. XIV		No P.M.	
Exp. XVI White rat ♂	October 25 Same as in Exp. XIV	October 28 Few parasites, eight days	Done Three days before death, 20 to 30 parasites	Done Very even temperature	November 9 Duration, twenty-three days	Same as in Exp. XIV		Parasites decomposed, enlargement of spleen and lymph glands observed.	
Exp. XXXI Large piebald rat ♂	November 21 Horse V Intraperitoneally with 1½ c.c. of blood	December 4 Few parasites in cubation, six days	Numerous parasites seen on December 6, none seen on December 9, a few seen doubtfully on remaining days. Parasites observed only on days on which temperature was above 101 F.	Irregular, up and down. A sharp rise on day before death	December 26 Duration, twenty-nine days	Red cells increased from 5,000,000 to 6,000,000	Exp LIX	Spleen, 5 × 3 × 2 cm., glands enlarged	
Exp. LXIV White and brown rat ♂	January 22 Horse VI Intraperitoneally with 1 c.c. of blood	No parasites seen after two days			January 28 Accidentally killed				
Exp. LXXXIII A Brown rat ♂	February 7 Horse VI Intraperitoneally with 1 c.c. of blood	February 17 One day's incubation, ten days	After 14th approximately, three parasites were found in 1 c.c. of blood. On March 1 parasites were observed, but were always present, increase gradual amount increased daily	Not taken	April 27 Duration, seventy-nine days		Exp CXIII Apparently Exp LXXXVI	Spleen, 6 × 4 × 3 cm., glands much enlarged, liver congested, colour rather dark, some were haemorrhagic	P.M. done immediately after death, animal killed
Exp. LXXXIII (B) Piebald rat ♀	February 7 Same as in Exp. LXXXIII A).	February 17 Two parasites in 1 c.c. of blood. Incubation, ten days	Up to March 1 parasites appeared sometimes one to two days to disappear for a similar period		Accidentally killed				
Exp. CXLII Small white rat. ♀	July 30 Horse VI Intraperitoneally with 2 c.c. of blood	August 9 Two parasites to cover. Incubation, ten days.	From August 9 to August 12 parasites increased in number, varying from one to thirteen in a field. Parasites absent all October 25. Two to seventeen. Present in blood August 31		August 31 Still alive				
Exp. CXLIII Small white rat. ♂	July 30 Horse VI Intraperitoneally with 2 c.c. of blood	August 9 Two parasites to thirty-five fields. Incubation, ten days.	Parasites present to two days. Absent to August 19, two to cover. August 21, one to eight fields. Absent up to August 31.		August 31 Still alive		Exp. CLV. Exp. CLVI. Exp. CLVII Exp CLVIII Exp. CLIX Exp CLX		
Exp. CXII Small white rat. ♀	April 23. Horse IX Intraperitoneally with 5 c.c. of blood	May 4 Few parasites to cover 18 fields. Incubation, seven days	Always present in blood, gradually increasing, very numerous on May 1		May 18 Duration, twenty-five days		Exp. CXIII	Spleen, 13 × 6 × 4 cm., slightly enlarged, some enlargement of lymphatic glands, no haemorrhages seen	

HUMAN TRYPANOSOME

INOCULATIONS IN RATS

FIRST PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen in preparations	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. XX (A) Small piebald rat ♀	October 29 Mr. Q Intraperitoneally with 10 drops of blood. Swimming parasites in preparation at time. Presumably in Blood would had been kept overnight.	Never became infective.			January 6 Died after six weeks				
Exp. XX (B) Small piebald rat ♀	October 31 Mr. Q Intraperitoneally with 1 c.c. of blood from finger	Never became infective							Rat reinoculated with blood from guinea-pig, Exp. XLIX in Exp. LV from Lemuel, child
Exp. XX (C) Large white rat ♂	November 1 Mr. Q Intraperitoneally with about 2 c.c. of blood, showing ten parasites in preparation	November 12 Two parasites seen in preparation. Incubation, nine days.	Parasites were never seen again. On February 14 rat reinoculated	Temperatures even	August 31 Still alive				Reinoculated positive
Exp. XX (D) Small piebald rat ♂	November 1 Mr. Q Intraperitoneally with 2 c.c. of blood	November 12 Two parasites seen in preparation. Incubation, nine days.	Parasites were present from the incubation until February 15, when they again appeared for a day. None have been observed since that date.		August 31 Still alive				
Exp. LXIX Tame black rat	January 29 Mr. Q Intraperitoneally with 1 c.c. of blood showing seven parasites in preparation	February 8 Seven parasites seen in preparation. Incubation, twenty days	Parasites were seen again in 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20. They were found in 1 to 7 in a field, usually in clumps, and parasites were occasionally absent		February 28 Died. Duration forty days	9·1 blood cells first enumerated	Exp. XV (c Exp. LXXXIV Exp. LXXXV Exp. LXXXVII	No enlargement of spleen. Lymphatic glands were not affected. No haemorrhages. Liver congested, and in places bruised, and subsequently died. It was observed that several suppurating pustules which had affected some of the rats. There was no pus in the testicles.	Has the lung disease the rabbits, more susceptible to the human experiment?
Exp. LXX Black and white tame rat.	January 29 Mr. Q Intraperitoneally with 1 c.c. of blood showing seven parasites in preparation.	Never became infected							Reinoculated April 14, as Exp. CIX, from boy at Falconda

INOCULATIONS IN RATS *(continued)*

FIRST PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XCVIII Black rat.	March 22 Mr. Q. Intraperitoneally with 1 c.c. of blood, taken from heart two hours after death, showing hæmatozoa. Parasites.	Never became infected.	..	..	August 31 Still alive.	..	..	..	..
Exp. XXVI Black tame rat.	November 7 Child at Lamoin. Case II Intraperitoneally with 1 c.c. of blood, showing one parasite to preparation.	November 14 Two parasites seen in cover-slip preparation. Incubation, seven days.	A few parasites seen in blood every four to six days, only occasionally numerous during the first month of infection. Intervals of absence became longer up to end of April.	Irregular.	Alive up to 7th of May when animal was killed by a dog at Dakar.	..	Exp. XXXIX. Exp. XL. Exp. XLI. Exp. XLII. Exp. XLIX. Exp. L. Exp. LI. Exp. LII Exp. LXXXIX.	.	..
Exp. XXVII Brown tame rat.	November 16. Boy at Guiguiz. Case IV Intraperitoneally with 1 c.c. of blood from the finger showing four parasites to cover.	November 23 One parasite seen in cover-slip preparation. Incubation, seven days.	The entrance and exit of parasites from the blood was as in rat XXVI up to the end of May. During June the rat was not examined. From the beginning of July parasites were generally found in the blood, and became fairly numerous for a fortnight before death.	Irregular.	August 3 Duration 265 days, nearly nine months.	Hæmoglobin and red cells greatly diminished just before death.	Exp. XXVIII. Exp. XXIX. Exp. LV. Exp. LVI. Exp. LVII. Exp. CXIV. Exp. CXV. Exp. CXVI. Exp. CXXX. Exp. CXXXI. Exp. CXXXII. Exp. CXXXIII. Exp. CXXXIV. Exp. CXLIV.	See P.-M. report, page 48.	The presence of chromatic granules in the parasites was a marked feature two weeks before death.
Exp. LXXI Tame rat. ♂	January 21 Native at Kamera. Case V Intraperitoneally with 1·5 c.c. of blood, showing two parasites to preparation.	Never infected	up to April 15 when re-inoculated from boy at Fatotenda (see Exp. CVIII			..	..	.	See Exp. CVIII.
Exp. CVIII White rat. ♂	April 15 Boy at Fatotenda. Case VI Intraperitoneally with 1·5 c.c. of blood, showing one parasite to preparation.	Parasites had not been seen up to time of death, June 3.			Sent home.	..	.	Rat preserved in formol. Spleen, 3·5 × 0·7 × 0·4 cm. No enlargement of lymphatic glands. Lungs riddled with abscesses.	Died in Liverpool before our return.
Exp. CIX Piebald rat.	April 15 Boy at Fatotenda. Case VI Intraperitoneally with 1·5 c.c. of blood, showing one parasite to preparation.	Parasites have not been seen up to the present time, August 31. Blood centrifuged negative	..	..	August 31 Still alive.	..	Exp. CLXXXIV.	..	Originally LXX.

EQUINE TRYPANOSOME

INOCULATIONS IN RATS

SECOND PASSAGE

Animal	Date and Method of Inoculation	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites counted per field	Duration of Infection in days	Result of Blood Examination	Characters of Blood	Subinoculations	Post-Mortem Appearances	Remarks
Exp. XVIII Piebald rat ♀	December 22 1 c.c. Exp. IV 8 Intraperitoneal Parasites continued to increase in number and were present in large numbers in every field of view	December 26 Numerous	Gradual increase in numbers up to December 31 when counted 50 parasites per field	Death on January 1	Parasites present	Slight diminution in number of red corpuscles. Some hæmoglobinæmia. Blood coagulates very readily on standing	Exp. XVIII Exp. XXXVI Exp. XXXVII Exp. XXXVIII	Enlargement of spleen and liver. Kidneys congested. Intestines normal	Death probably hastened by subinoculation
Exp. LXV Piebald rat ♀	January 14 Subcutaneous 1 c.c. Normal Exp. XI Intraperitoneal 1 c.c. Inoculation of Exp. XI No parasites seen Strain Horse I	January 18 Numerous Parasites present	Gradual increase in numbers up to January 21 when counted 30 parasites per field	March 21 Animal alive and in good condition 66 days after inoculation			Exp. LXVIII		Animal killed during absence from laboratory
Exp. LXVI Tame rat ♂	January 15 Subcutaneous 1 c.c. Normal Exp. XI Intraperitoneal 1 c.c. Inoculation of Exp. XI No parasites seen Strain Horse I	January 21 Numerous Parasites present 6 days	Numerous, about 1 in every field of view	April 18 Death 93 days after inoculation				N. P. M.	
Exp. CLIII White rat ♀	August 4 Normal Exp. XI Intraperitoneal 2 c.c. of blood No parasites seen Strain Horse I	Never became infected		August 31 Still alive					Blood centrifuged many times No parasites seen
Exp. LXVII Large piebald rat ♂	January 15 Good Exp. X Intraperitoneal 3.5 c.c. of blood No parasites seen Strain Horse I	January 26 Numerous Inoculation 11 days	Gradual increase in numbers	February 25 Death 41 days after inoculation			Exp. LXXIX Exp. LXXV	Mucous membranes and skin yellowish. Liver and kidneys congested. Spleen 6.5 × 1.8 cm. Guinea not enlarged nor haemorrhagic, oedematous and yellowish hue. One parasite in heart blood.	
Exp. LXVIII Tame brown rat ♂ Reinoculation	January 15 Good Exp. X Intraperitoneal 3.5 c.c. of blood No parasites seen Strain Horse I	Never became infected							Re-inoculated, March 20, from rat Exp. LXV third passage Strain Horse I
Exp. XCVI Tame brown rat ♂	March 21 Good Exp. X Intraperitoneal 3 c.c. of blood No parasites seen Strain Horse I	March 28 Quite positive Incubation, eight days	Gradual increase in numbers up to April 21	About April 23 Rather [illegible] about thirty-four days					Killed while away from laboratory
Exp. LIV White rat ♀	December 26 Rat Exp. XXXI Intraperitoneally 2 c.c. of heart blood aseptically taken. Many parasites seen Strain Horse V	January 11 Many parasites Incubation, 16 days	Gradual increase in numbers 20 per c.mm. on March 6	Very irregular	January 26 Death 31 days after inoculation	Red cells fall from 8,000,000 to 3,000,000 but no death	Exp. LXIII	Spleen and glands enlarged. Abscess between rectum and bladder. Genitals pigmented	Death hastened by pernosis
Exp. CLV Piebald rat. ♂	August 10 Rat Exp. CXLIII Intraperitoneally 1 c.c. of blood Strain Horse VI	August 15 Four parasites. Incubation, five days.	Parasites almost constantly present		August 31 Still alive	..	.		
Exp. CLVI Piebald rat ♀	August 12 Rat Exp. CXLIII Intraperitoneally 2 c.c. of blood Strain Horse VI.	August 17 Positively dead. Incubation, seven days	Parasites constantly present, usually two to four to a field.		August 31 Still alive	.	.		..

HUMAN TRYPANOSOME

INOCULATIONS IN RATS

SECOND PASSAGE

Animal	Date and Method of Inoculation	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites counted per field	Duration of Infection in days	Result of Blood Examination	Characters of Blood	Subinoculations	Post-Mortem Appearances	Remarks
Exp. LXXXIV Large white rat ♀	February 8 Rat Exp. LXIX Intraperitoneally 1 c.c. of blood No parasites seen Strain Mr Q	February 16 Few parasites Incubation, eight days	Parasites rather plentiful but not increasing further	Not taken	August 31 Still alive				..
Exp. LXXXV Large piebald rat ♀	February 8 Rat Exp. LXIX Intraperitoneally 1 c.c. of blood No parasites seen Strain Mr Q	February 16 Little parasites Incubation, eight days	Parasites present till February 18, then increasing, and present in large numbers till March 16, when counted 30 per field. Disappeared April 8	No link	August 31 Still alive				
Exp XX Large white rat ♂ Reinoculation	February 14 Rat Exp. LXIX Intraperitoneally 6 c.c. of blood, containing many parasites. Strain Mr Q	February 17 Two parasites seen	No parasites present on February 19, dead by date		August 31 Still alive				Rat first inoculated, November 13, with blood from Mr Q (see first passage)
Exp. XXXIX Large tame black rat ♂ Reinoculation	November 3 Rat Exp. XXVI Intraperitoneally 1 c.c. of blood. Trypanosomes seen	December 8 Few parasites Incubation, eight days	Parasites appeared till March 16, when counted 30 per field. Disappeared April 6	4 days 3 April Trypanosomes seen	May 31 Animal alive and in good condition	Normal	Exp. XLIV Exp. XLV Exp. XLVI Exp. LXII Exp. CXI		Up to December 4 no parasites had been seen, but were looked for on that day
	December 4 Intraperitoneally 1 c.c. of blood from same rat, containing numerous parasites Strain Lamian								The regular appearance of the parasites on the previous day assembly
Exp. XLI Large white rat ♀	December 4 Rat Exp. XXVI Intraperitoneally 1 c.c. of blood Parasites seen in small numbers Strain Lamian	Never observed	..						Re-inoculated from both rat Exp. LXV third passage
Exp. LXXXIX Small tame black rat ♂	December 21 Rat Exp. XXVI Intraperitoneally 1 c.c. of blood, containing many parasites Strain Lamian	March 16 Few parasites Incubation, eighty-five days	Parasites increased to [illegible]		May 31 Still alive				

INOCULATIONS IN RATS (*continued*) — SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P. M. Appearances	Remarks
Exp. LV Small piebald rat. ♂	January 6 Rat. Exp. XXVII Intraperitoneally 1·0 c.c. of blood, containing six parasites to preparation. Strain Ganjar.	January 9 One parasite seen Incubation, three days.	Absent on January 12, present on 14th. Absent until February 1, present up to 6th. Reappeared February 24 for two days. Absent up to date.	..	August 31 Still alive.	..		..	..
Exp. LVI Small Lusc black rat	January 6 Rat. Exp. XXVII Intraperitoneally 1·0 c.c. of blood, as in Exp. LV.	Never observed.	..	..	August 31 Still alive.	..	..	..	..
Reinoculation	July 23 Intraperitoneally 1·0 c.c. of blood from same rat. Strain Ganjar.	September 11 One parasite to two preparations.	..	..	..	..	..	..	..
Exp. CXV White rat. ♂	May 14 Rat. Exp. XXVII Intraperitoneally 0·25 c.c. of blood. Strain Ganjar.	May 21 Two parasites to preparation. Incubation, seven days.	From May 22 to June 4 none seen. Present up to June 7. Not examined again until July 4, constantly present to date. Average two to a field.		August 31 Still alive.		Exp. CXLIX. Exp. CL.	..	Rat increased in weight from 176 gm. to 184 gm.
Exp. CXVI White rat. ♂	May 14 Rat. Exp. XXVII Intraperitoneally 0·25 c.c. of blood. Strain Ganjar.	May 21 One parasite to every two fields. Incubation, seven days.	Parasites more frequently seen than in Exp. CXV. Up to June 7, longest period of absence three days. Constantly present from July 18 to death.	..	September 4 Died. Duration, 146 days.		Exp. CXLIX. Exp. CL.	Body decomposed. Spleen much enlarged, 7 × 4·12 × 3 mm. Abdominal, mesenteric, retroperitoneal and bronchial glands enlarged. Some retroperitoneal and mediastinal glands very dark coloured. Heart and lungs healthy. No parasites seen.	Rat increased in weight from 165 gm. to 224 gm.

INOCULATIONS IN BUSH RATS

Exp. L Large bush rat. *Conilurus cinereus*	December 15 Rat. Exp. XXVI Subcutaneously 0·2 c.c. of blood, containing one parasite to preparation.	January 6 Four parasites seen. Incubation, fifteen days.	Present up to January 11. Absent until January 22, then on fairly constant in blood. Numbers varied, gradually increasing, then decreasing to be absent for one to two days	..	April 13 Killed by sun stroke. Duration, 112 days.	..	Exp. LXXXII.	Glands not enlarged. Inguinal glands congested. Spleen, 7·5 × 1·5 cm., dark. Heart and lungs congested.	As no parasites were seen after six days, rat reinoculated from same rat on December 22.
Reinoculation	December 22 Intraperitoneally 0·25 c.c. of blood from same rat. Strain Lamma.	..	..	..	..	..	..	..	..
Exp. LII Large bush rat. *Conilurus ambiguus*	December 22 Rat. Exp. XXVI Intraperitoneally 0·5 c.c. of blood, containing four parasites. Strain Lamma.	January 5 Two parasites seen Incubation, fourteen days.	Parasites present up to January 19, absent till January 22.	..	January 22 Rat escaped.	..	Exp. LVIII. Exp. LIX. Exp. LX. Exp. LXI.	..	

EQUINE TRYPANOSOME

INOCULATIONS IN RATS

THIRD PASSAGE

Animal	Date of Inoculation & Method of Inoculation	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites, Whether Scanty or Abundant, Periodicity	Range of Temperature, Remarks	Result: Date of Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. XXXVIII Brown rat ♀	November 1 Rat Exp. XVIII Intraperitoneal injection of 1 c.c. of blood containing many trypanosomes. Strain Horse I.	December 1 Many parasites. Infection rapidly overwhelming.	Numbers increased rapidly and remained very high. Periodicity not observed.	Irregular, 100° to 102° F. Fatal termination 2 days before death.	January 1 Died. Duration, seventeen days.	Red corpuscles reduced to 3,000,000 by December 28.	Exp. XLVIII	Spleen 4·7 × [illegible]. Normal. Liver enlarged, pale, mottled, congested. Mesenteric glands enlarged. Lungs congested. Kidneys congested. Intestines normal. Bladder contained a few drops of urine. Heart contained a few clots of blood. Brain normal. Marrow of femur pale. Subcutaneous tissue normal. Peritoneal cavity contained a few drops of clear fluid.	Death probably hastened by anæmia.
Exp. LXVIII Field-mouse ♂ Reinoculation	March 2 Rat Exp. LXV Intraperitoneal injection of 1 c.c. of blood containing many trypanosomes. Strain Horse I.	March 21 Six parasites. Infection developing very slowly.	Parasites soon became scanty. Blood not collected.		April 13 Died. Duration, twenty-four days.			Spleen 1·7 × 1·4 cm. Slightly enlarged, but not abnormal in appearance. Liver, kidneys, lungs, heart, and brain normal. Peritoneal cavity contained a few drops of clear fluid. Bladder contained a few drops of urine. Subcutaneous tissue normal.	Immediately after death subcutaneous inoculation of blood. January 15, from guinea-pig. Exp. X. Several passages. Latent infection.

FOURTH PASSAGE

Exp. XCVII Piebald rat ♂	March 20 Goat Exp. XXXV Intraperitoneal injection of 10 c.c. of blood containing many trypanosomes. Strain Horse I.	March 28 Eight parasites. Infection, eight days.	Numbers varied, never very numerous. Absent on April 2.		April 13 Died. Duration, twenty-four days.			Spleen, 6 × 3·5 × 0·5 cm. Very large and friable. All glands enlarged and reddened. Marrow of femur pale. Intestines normal. Bladder contained a few drops of urine. Heart contained a few clots of blood. Brain normal. Peritoneal cavity contained a few drops of clear fluid. Subcutaneous tissue normal. Lungs congested. Liver enlarged, pale, mottled. Kidneys congested.	Probably died from salt and starvation.

FIFTH PASSAGE

Exp. LXXVII A Piebald rat ♀	February 2 Bullock, Exp. XLVIII Intraperitoneal injection of 15 c.c. of blood containing many trypanosomes. Strain Horse I.	February 10 One parasite to field. Incubation, eight days.	Numbers increased rapidly and remained so up to March 1.		March 5 Died. Duration, thirty-one days.		Exp. XCIV.		Inoculated at P.M. of bullock, and immediately after death. Died while absent from laboratory.
Exp. LXXVII B Piebald rat ♂	February 2 Intraperitoneally 4·5 c.c. of blood as in Exp. LXXVII A.	February 10 Two parasites to a field. Incubation, eight days.	As in Exp. LXXVII A.		March 2 Killed purposely.			Spleen 5 × 0·4 × 0·3 cm. Glands slightly enlarged, not haemorrhagic. Bone marrow pale. Subcutaneous tissue oedematous.	
Exp. LXXVII C Piebald rat ♀	As in Exp. LXXVII A.	February 8 Ten parasites. Incubation, six days.	As in Exp. LXXVII A.		March 5 Died. Duration, thirty-one days.		Exp. XCIII		Died while absent from laboratory.

HUMAN TRYPANOSOME

INOCULATIONS IN RATS

THIRD PASSAGE

Animal	Date of Inoculation & Method of Inoculation	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites, Whether Scanty or Abundant, Periodicity	Range of Temperature, Remarks	Result: Date of Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. LVIII Large brown rat ♂	January 6 Rat Exp. LII Intraperitoneally 1 c.c. of blood, containing many trypanosomes. Strain Lamban.	January 11 One to every field. Incubation, seven days.	Present two days, viz. January 11 and 12, then absent. March 26 to April 1. Four to each field. July 24, negative.		August 31 Still alive.				
Exp. LIX Large black rat ♂	January 6 Rat Exp. LII Intraperitoneally 1 c.c. of blood, containing many trypanosomes. Strain Lamban.	January 15 Two to three parasites to a field. Incubation, nine days.	Present first eight days, then rare to absent. Scanty again from March 26 to April 1. Four to each field. July 24-27 absent. August 31 absent.	Regularly remittent, 101° to 103° F., occasionally 104° F.	August 31 Still alive.				
Exp. LX Brown rat ♂	January 6 Rat Exp. LII Intraperitoneally 1 c.c. of blood, containing many trypanosomes. Strain Lamban.		Present January 22 to February 2. Present, though scanty, with no gaps, from March 20 onwards. Last seen March 26, when becoming rare. July 15, twelve to the field.	Regularly remittent, 101° to 104° F., occasionally 104·4° F.	January 15 Found dead this morning. Duration, 19 days.	Not marked.	Exp. CXVIII Exp. CXXII Exp. CXXV Exp. CXXVI Exp. CXXVII	Immature autopsy. Right lung and part of left lung collapsed, solid, and airless, congested. Liver and kidneys congested. Traces of peritoneal fluid containing few parasites, no gaseous bubbles. Bone marrow dark, fatless, except branched, not markedly enlarged. No gaseous bubbles in other abdominal organs. None in mesenteric vessels, spleen, liver. Examination from Lorge with magnification 1,000 diameters of parasites, and of protoplasmic inclusions containing chromatin spots of varying sizes, chromatin sometimes forming rings. Bombay Subinoculation of parasites.	
Exp. LXI Black rat ♀	January 6 Rat Exp. LII Intraperitoneally 1 c.c. of blood, containing many trypanosomes. Strain Lamban.	January 18 Incubation, twelve days.	Almost always present, but scanty, from January 18 to April 2. Last seen March 26.	Regularly remittent, 101° to 103° F., occasionally 104° F.	August 31 Still alive.	Not marked.			
Exp. XLI Large white rat ♂ Reinoculation	February 6 Bullock Exp. L. Intraperitoneal injection of 10 c.c. of blood containing many trypanosomes. Strain Lamban.	March 3 Four parasites to every five fields. Incubation, twenty-five days.	Present for two or three days at long intervals.	Irregular.	May 8 Killed by a dog.				Passed on inoculated. Second passage from rat Exp. XXVI, but never infected.
Exp. LXXVIII Black rat ♂	February 4 Exp. [illegible] Exp. XLIX Intraperitoneally 1 c.c. of blood, containing many trypanosomes. Strain Lamban.	February 9 Three to seven fields. Incubation, five days.	Present, with two intervals of four and seven days, with April 2 to 7 inclusive. July 24 absent. August 31 absent.	Not taken.	August 31 Still alive.				

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites per cmm. and General Infectivity	Typical Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. LXXIX									
Large black rat ♂	Feb. 10 A.V. Exp. XLIX Intraperitoneally 2 c.cm. blood, two parasites to field. Strain L.	February 13	Present only on April 8, 21, 26, 27, 28, 29, 30, and May 1, 2, 3, 4, 5, 6, and 7 days. Never more than one to field. On 21 occasions, August 31 negative.	Not taken.	August 31 Still alive.	.	Exp. XCII.		..
Exp. LXXXI									
Large white rat ♀	February 6 B. Exp. L. Intraperitoneally 2 c.cm. blood, four parasites to field. Strain L.	February 20	Very occasionally seen. Never more than one to field.	Not taken.	April 4 Found sunstroke in Steamer			Well-nourished. Glands not enlarged. Spleen 3 ins. × 1½ ins. Lungs and right heart congested. No excess of peritoneal fluid.	Parasites not transmitted to young. Latter were susceptible to inoculation.
Exp. CII									
Rat ♀	March 2nd Rabbit. Exp. XLII (P. M.) Intraperitoneally 1 c.cm. blood. Strain L.	Never became patent.		..	August 31 Still alive.	.	.		.
Exp. CV									
Small pale rat ♀	April 3 Guinea-pig. Exp. XLIX P. M. Subcutaneously 1 c.cm. blood. Strain L.	Never seen in 4 days.			August 17th Duration, 136 days.			Spleen 3 ins. × 1½ ins. × ½ in. Bronchial and submaxillary glands enlarged. Lungs full of caseous material.	Previously inoculated as Exp. XX B from Mr. Q., but not infected.
Reinoculation									
Exp. CXLIX									
Bush rat ♀	August 4 Rats. Exp. CXV, CXVI Intraperitoneally 1 c.cm. blood, two parasites to field. Strain G.	August 7 One to a field. Increasing.	Present, as previously, except on August 17. Very numerous August 21.	..	August 26 Died, 6, twenty c.cm.	..		Commencing decomposition. Spleen and glands not enlarged. Lungs healthy. Heart blood showed twenty to thirty active parasites to field.	..
Exp. CL									
Bush rat ♂	August 4 Rats. Exp. CXV, CXVI Intraperitoneally 1 c.cm. blood, two parasites to field. Strain G.	August 8 Three to five to field. Increasing, four days.	Numerous until August 24. Never such slides.	..	August 31 Still alive.	..	Exp. CLXI. Exp. CLXII.	.	Bred from either rat LX or rat LXI.
Exp. XCV									
A Large [illegible] rat ♀	March 17 Rabbit. Exp. LXXXVII Intraperitoneally 1 c.cm. blood, two parasites to field. Strain M. Q.	March 25 Never become patent. Increasing, four days.	Present two or three days. Subsequently present but few and very small. Never more than one to field August 31, one to a slide.	Not taken.	August 31 Still alive.	..	..	..	..
Exp. XCV									
B Large [illegible] rat ♀	March 17 Rabbit Exp. XCV A.	.	Present April 21, 22, 29. Very few seen.	Not taken	Lost on shipment home.	.	..	..	..

INOCULATIONS IN RATS *(continued)*

THIRD PASSAGE

			Number of Parasites Noted on Each Examination	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P. M. Appearances	Remarks
Exp. CXL									
	[illegible]	[illegible]	Never seen since August 14		August 31 Still alive.	..	..	..	..
Exp. CXLI									
	July 3 Rat Exp. LXXXVII Intraperitoneally 2 c.c. of blood, rat parasites seen in Mr. Q.	August 14 [illegible]	September 1, no trace seen	..	August 31 Still alive.	.		.	

FOURTH PASSAGE

Exp. CXXIII									
	July 14 Rat Exp. LX Intraperitoneally 2 c.c. of blood, rat parasites seen in Mr. Lamson.	No trace.		..	July 21 Died.		.	Nothing abnormal. No parasites in blood. Spleen 3.5 x 0.7 x 0.3 cm.	This rat was born of a rat infected with human trypanosome.
Exp. CXXIV									
	July 14 Rat Exp. LX Intraperitoneally 2 c.c. of blood, rat parasites seen in Mr. Lamson.	August 4 Blood centrifuged. Dewsnap.		..	August 31 Still alive.	..	.	..	..
Exp. CLXI									
	August 11 Rat Exp. CL Intraperitoneally 1 c.c. of blood, rare parasite in blood. Mr. Graham.	August 15 Two to cover. Incubation, five days.	..	..	August 31 Still alive.	..	..	..	..
Exp. CLXII									
	Aug. 11 Rat Exp. CL Intraperitoneally 1 c.c. of blood, rare parasite in blood. Mr. Graham.	August 15 Over to six fields. Incubation, five days.	..	..	August 31 Still alive.	..	..	..	.

EQUINE TRYPANOSOME

INOCULATIONS IN MICE

SECOND PASSAGE

IV

Animal	Date, Number, and Mode of Infection	Date of Appearance of Parasites in Peripheral Blood	Number of Parasites per c.mm. (Counting Chamber)	Type of Temperature Reaction	Result: Died or Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. CLVII Black and white mouse	August 7 Rat Exp. CLVIII Intraperitoneally 0.2 c.c. blood Horse A1	August 14 Large numbers present	August 21 Enormous numbers in enormous excess to rats						August 24 Lost
Exp. CLVIII Black and white mouse	August 7 As in Exp. CLVII	August 14 Large numbers present	August 21 Enormous numbers in blood						August 24 Animal lost
Exp. CLIX Brown and white mouse	August 7 As in Exp. CLVII	August 15 Parasites very rare, only one found in 15 minutes' search	August 21 Blood negative on August 22 one parasite in 10 fields		August 21 Moribund				
Exp. CLX Brown and white mouse	August 7 As in Exp. CLVII	August 15 Parasites very rare, only one found in 10 minutes' search	Parasites very numerous up to time of death		August 27 Died on 20th, thirteen days			Animal very much decomposed. Spleen, 11 mm. by 9 mm. Lung pus sacs seen in blood	

INOCULATIONS IN WILD MICE

THIRD PASSAGE

Exp. LXXIV Field mouse (Mus sylvaticus)	January 31 Rat Exp. LXXII Intraperitoneally 0.2 c.c. blood, containing numerous parasites Serum II. set I	February 2 A few trypanosomes seen in mouse's blood	Parasites present in moderate numbers, but not numerous, on February 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, March 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, April 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, May 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, June 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, July 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, August 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, September 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, October 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, November 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, December 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, January 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, February 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, March 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

INOCULATIONS IN MICE *(continued)* — FOURTH PASSAGE

Animal	Date, Source, and Method of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen in a Preparation	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. CXIX Exp. CXX Exp. CXXI Exp. CXXII White mice.	July 6 Guni. Exp. CXI. P.-M. [illegible] blood [illegible] in Lamb-man.	Never infected.	..	..	..	..	..	..	..
Exp. CXXV White mouse.	July 14 Rats. Exp. LX Intraperitoneally with 2 [illegible] parasites. Strain Lamb-man.	August 1 Exceptional to perceive. Incubation, twenty days.	Parasites never observed again.	August 15 Duration, thirty-two days.	..	..	..	Body too decomposed.	..
Exp. CXXVI [illegible] white mouse.	July 14 As Exp. CXXV.	August 21 Two parasites in stained film, after [illegible].	Parasites never observed again.	August 31 Duration, forty-eight days.	..	..	..	Body too decomposed.	

INOCULATIONS IN WILD MICE — THIRD PASSAGE

Exp. LXXIII Wild [illegible] from M.C. [illegible] Location [illegible]	January 30 Puppy. Exp. LVII Intraperitoneally each [illegible] blood, containing four trypanosomes [illegible] Strain Gunjur.	February 5 Increasing [illegible] Incubation, six days.	Blood of these mice examined every other day through February and half of March. At most twelve parasites to field. Parasites were generally found to be present in the peripheral blood for four to six days, and then absent for two to four days.	..	One mouse died on March 10, another on the 12th, and the other two were killed by accident about a week later.	..	..	Autopsy immediately after death on mouse dead on April 12. No fluid in serous cavities, slight patchy congestion of lungs. Heart full of blood, showing four trypanosomes. Spleen congested, 1.7 × 0.5 × 0.2 cm. Liver congested, a hair-ball found in stomach. Intestines normal, abdominal glands and also mesenteric glands, slightly enlarged, not congested. Axillary and inguinal glands could not be made out.	Death probably hastened by injuries received in cage.
Exp. LXXXII Wild [illegible] from M.C. [illegible] Locality [illegible]	February 6 Puppy. Exp. I Intraperitoneally with [illegible] blood, showing four parasites to field. [illegible] Lamb-man.	February 8 Considerable [illegible] [illegible] parasites per preparation. Incubation, [illegible]	Parasites never very numerous in the blood, at the most two to a field. They never were constantly present in the blood, after disappearance two to four days would elapse before they were seen again. Observations were made up to April 28.	..	One mouse died [illegible] week after inoculation, probably from injury, the other two on the passage home.	..	..	..	It was difficult to keep these house-mice in health in captivity. NOTE.—In two of the mice, on rare occasions, a flagellate organism was seen in the blood, having a long flagellum at one end.

INOCULATIONS IN WILD MICE — FOURTH PASSAGE

Exp. XCII M.C. by [illegible] [illegible] [illegible]	March 2 Rats. Exp. LXXIX Intraperitoneally with [illegible] blood, containing one trypanosome to field. [illegible] Lamb-man.	March 4 Three mice had one parasite to cover, three with four parasites to cover. Incubation, two days.	Persistency of parasites was noticeable in the wild house-mice up to April 28. Parasites never numerous in the peripheral blood.	..	Two died while away in bush; one on voyage home; one soon after arrival, one still alive, August 11.	..	..	No P.-M.	Mice difficult to keep healthy in captivity.

EQUINE TRYPANOSOME

INOCULATIONS IN GUINEA-PIGS

FIRST PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XIII Guinea-pig. Weight 488 gm.	October 17 Horse I Intraperitoneally 1·5 c.c. [illegible] from vena cavam P.-M. No parasites seen.	October 25 Very few seen. Incubation, eight days.	Later constantly. Very numerous post-mortem. Lowered death 88, except comm.	Irregular. 102° to 103° F.	November 15 Died. Duration, twenty-nine days.	No diminution of red cells.	..	Some clear fluid in abdomen. No peritonitis. Spleen dark. Glands not enlarged. Slight parietal peritoneal ecchymosis opposite spleen.	Convulsions before death. Lordosis at death.

SECOND PASSAGE

Exp. XXII Guinea-pig.	[illegible] Rat. Exp. IX (II) Intraperitoneally 0·5 c.c. of blood. Numerous parasites seen. Strain Horse I.	November 1 Two parasites. Incubation, two days.	Parasites [illegible] constantly present. Varied between 24 and 50,000 per c.mm.	Persistently elevated 103° to 104° F.	November 28 Died. Duration, thirty-one days.	No diminution of red cells.	Exp. XXXIII. Exp. XXXIV. Exp. XXXV.	Performed immediately after death. Oil haematoma under skin over sternum, another near left inguinal glands. Spleen slightly enlarged, anterior end ruptured, blood in peritoneal cavity. Liver pale. Other organs healthy. Glands enlarged. Abdominal and mesenteric glands haemorrhagic.	Animal died after handling while taking blood.
Exp. CXIII Guinea-pig. ♂	May 14 Rat. Exp. CXII Intraperitoneally one drop of [illegible] Strain Horse IX.	Never became infected	..	..	August 31 Still alive.	..	..	..	..

HUMAN TRYPANOSOME

INOCULATIONS IN GUINEA-PIGS

SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XLIX Guinea-pig. Weight 453 gm.	December 15 Rat. Exp. XXVI Intraperitoneally 0·5 c.c. of blood. One parasite seen. Strain Lammin.	January 5 Blood centrifuged, a few seen. Incubation, twenty-one days?	January 21, one parasite. January 22 fairly numerous, almost constantly present to death. Numbers varied.	Irregular. 102° to 104° F.	April 5 Died. Duration, 111 days.	Nothing marked.	Exp. XLII. Exp. LXXVI. Exp. LXXVIII. Exp. LXXIX. Exp. XCIX. Exp. CV.	See P.-M. report, page 47.	Became thin week before death.
Exp. CXIV Guinea-pig. ♀	May 13 Rat. Exp. XXVII Intraperitoneally 0·5 c.c. of blood. Strain Gunjur.	May 25 One parasite. Incubation, twelve days.	May 27, Four parasites present. Absent until August 31. Two to a field seen.		August 31 Still alive.	..	..	..	..
Exp. CXXXIII Guinea-pig.	July 20 Rat. Exp. XXVII Intraperitoneally 1·5 c.c. of blood. Many parasites seen. Strain Gunjur.	August 31 Blood centrifuged. Two parasites.	..	..	August 31 Still alive.	..	..		Weight 695 gm., July 21. Weight 857 gm., August 14.

EQUINE TRYPANOSOME

INOCULATION IN RABBIT — **FIRST PASSAGE** — VI

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. IX									
(a) White rabbit. ♀	October 12 Horse I Intraperitoneally. Numerous parasites in blood.	October 25 Numerous. Incubation, thirteen days.	Generally present and very numerous 2,000 to 1 c.mm.	October 18, rose; October 19, 104·8° F.; October 25, 105·4° F. Remained high; November 2-4, 105° F.; November 23, 105·2° F.	November 24 Duration, fifty-three days.		..	Decomposition commencing. Testicles not swollen. No discharge from mucous membranes nor eyes. Spleen not enlarged, dark, diffluent. Glands not enlarged. Peritoneum normal. Some fluid in pericardium. Heart muscle pale, flabby. Lungs congested, oedematous. Brain slightly congested.	Weight, October 12, 2,000 gms.; November 24, 1613·5 gms.

HUMAN TRYPANOSOME

INOCULATIONS IN RABBITS — **FIRST PASSAGE**

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. CVII									
Black rabbit. ♀	April 15 Boy. (Liverpool), Case VI Intraperitoneally 1·5 c.c. of blood.	Never became infected	..	..	August 31 Still alive.	..	..	..	..

SECOND PASSAGE

Exp. LII									
Black rabbit. ♂	December 4 Rab. Exp. XXVI Intraperitoneally 1 c.c. of blood. Twelve parasites to c.mm.	Never became infected	..	Steady, 103° to 104° F. until January 9. Subsequently septic in type.	March 27		Exp. CII	Chronic abscess in spleen. Perisplenitis.	Suffered from suppurative orchitis for three weeks in February.
Reinoculation	February 5 Guinea-pig. Exp. XLIX 1·5 c.c. of blood. Two parasites to c.mm.								
Reinoculation	March 3 Rab. Exp. XXVI Intraperitoneally 1·5 c.c. of blood. Eight parasites to c.mm. Strain Lamnim.								
Exp. LI									
White guinea-pig. ♀	December 22 Rab. Exp. XXVI Intraperitoneally 1·5 c.c. of blood. One parasite to c.mm. Strain Lamnim.	January 12 Two to c.mm. Incubation, twenty-one days.	Present rarely up to Jan. 31. Present again Apr. 27 and July 21.	Slightly raised when parasites present.	August 31 Still alive.	None.	..	..	Weight December 22, 1587 gms. March 31, 2040·6 gms.

EQUINE TRYPANOSOME

INOCULATIONS IN MONKEYS

THIRD PASSAGE

Species	Date of Inoculation and Material Inoculated	Date of Appearance of Trypanosomes in the Peripheral Blood	Number of Parasites Annular Forms also present?	Typical Temperature Reaction	Result Date of Death	Changes in Blood.	Subinoculations	P.-M. Appearances	Remarks
Exp. XXIII Small Indian monkey. *Cercopithecus sphinx*. ♀	December 1 Rat Exp. LXVIII about the same as 61 c.c. blood, 34 hours after death from Strain Horse I.	December 14 First observed. Incubation, 13 days.	..	..	..	..	..	.	Escaped during night, December 14.
Exp. LXIII Small Indian monkey. *Cercopithecus sphinx*. ♂	January 1 Rat Exp. LIX [illegible] 3 c.c. blood, 24 hours after death from Strain Horse V.	Never became infected.			January 24 Killed when very point of death.	..	Exp. LXXII	Lungs, heart, and spleen normal. Liver showed marked fatty degeneration. Stomach contained altered blood, mucous membrane much congested.	Monkey ill three days before death, probably poisoned. Two rats inoculated with 3·5 c.c. heart blood directly after death; never infected.
Exp. LXXV Hybrid Baboon *Cercopithecus sphinx*. ♂	February 21 Rat Exp. LXVII Intraperitoneally 2·5 c.c. blood, human trypanosome Strain Horse I.	Never became infected.			February 25 From heatstroke	.	..	No microscopical lesions. Right heart gorged with blood.	Rectal temperature before death, 110° F.

SIXTH PASSAGE

Exp. XCIII Small Indian monkey. *Cercopithecus sphinx*. ♀	March 3 Rat Exp. LXXVII Intraperitoneally 3 c.c. blood, very numerous parasites. Strain Horse I.	Never became infected.	.	.	August 31 Still alive.	..	..	..	Formerly LXXVI. human trypanosome q.v. Rat inoculated 3 c.c. blood, April 6; not infected.

HUMAN TRYPANOSOME

INOCULATIONS IN MONKEYS — THIRD PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of parasites usually seen and persistency	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XLIV Young baboon, *Cynocephalus sphinx*. ♀	December 8 Rat. Exp. XXXIX Subcutaneously 1 c.c. of blood. Nine parasites to field. Strain, Lamum	Never became infected.	..	..	January 7	..	..	..	..
Exp. LXII Young baboon, *Cynocephalus sphinx*. ♀	January 16 Rat. Exp. XXXIX Subcutaneously 0·5 c.c. of blood. Numerous parasites. Strain Lamum.	Never became infected.	..		February 22 From sunstroke.	..	..	..	..
Exp. LXXVI Young baboon, *Cynocephalus sphinx*. ♂	January 31 Guinea-pig. Exp. XLIX Intraperitoneally 0·8 c.c. of blood. Numerous parasites.	Never became infected.	..		August 31 Still alive.	..	..		March 3 Inoculated with horse parasite (Exp. XCIII) q.v.
Reinoculation	February 18 Same animal 1 c.c. of blood. Four parasites to field. Strain Lamum								
Exp. XCIX Young baboon, *Cynocephalus sphinx* ♂	March 24 Guinea-pig. Exp. XLIX Intraperitoneally 5 c.c. of blood. Numerous parasites. Strain Lamum.	Never became infected.	..	..	August 31 Still alive.	..	..	..	..

INOCULATION IN CHIMPANZEE — THIRD PASSAGE

Chimpanzee. ♀	July 24 Rats. Exps. CXV, CXVI Subcutaneously 2·5 c.c. of blood. Two parasites to field. Strain Gambia.	August 3 One parasite seen and one *Filaria perstans*.	Present only occasionally and in small numbers.	Two periods of fever (101°-104° F. a week apart in first fortnight, when parasites present. Curve since then irregular. See Chart.	August 31 Still alive.	No decrease in red cells and Hb. No increase of white cells.*	..	..	..

* DIFFERENTIAL LEUCOCYTE COUNT

	August 3	August 28
Neutrophiles	56 per cent.	29 per cent.
Eosinophiles	7 per cent.	7 per cent.
Small mononuclears—Lymphocytes	27 per cent.	32 per cent.
Do. with irregular nuclei	6 per cent.	1 per cent.
Large mononuclears—Large lymphocytes	1·5 per cent.	20 per cent.
Large mononuclear	1 per cent.	6 per cent.
Transitionals	4 per cent.	6 per cent.

INOCULATIONS IN DOGS **FIRST PASSAGE** VIII

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XI Adult native bitch.	October 16 Horse I Intraperitoneally 3 c.c. of blood. One parasite seen	October 25 After seven days' incubation, nine days.	Numbers increased to October 31. Never numerous. Up to February very scanty, only occasionally seen. Absent up to date.	With appearance of parasites temp. 104.4° F. Rose 1.2° to 1.4° F. coincident with each reappearance of parasites.	August 31 Still alive.	..	Exp. LXV. Exp. LXVI. Exp. CLIII.	..	No symptoms. Is strong and well. Rats, Exps. LXV, LXVI, became infected.
Exp. XII Native puppy, three weeks old	October 16 Horse I Intraperitoneally 2 c.c. of blood. One parasite seen.	October 24 Numerous parasites. Incubation, eight days.	Parasites never absent, gradually increased up to death. November 15, 23,000 parasites per c.mm.	Remittent after parasites appeared.	November 17 Died. Duration, thirty-two days.	..	Exp. XXIV.	Subcutaneous tissue of abdomen and thorax markedly oedematous. Small abscesses of liver. Recent pericarditis, marked over heart. Spleen dark, diffluent. All abdominal glands enlarged. Mesenteric and omental, brown coloured, gelatinous. Chains of glands along aorta and iliac arteries ditto.	Bush rat, Exp. XXIV, infected.
Exp. XXX Native dog, half-grown.	November 28 Horse V Intraperitoneally 3 c.c. of blood. Few parasites seen.	December 9 Three parasites. Incubation, eleven days.	Never numerous, about three to six to preparation. For a week before death about 13,000 parasites per c.mm.	Remittent from three days before parasites appeared till death. Twice 105° F., usually 103° to 104° F.	January 3 Died. Duration, thirty-six days.	..	..	Six hours after death. Mucous membranes normal. About 280 c.c. straw-coloured fluid in abdomen. Spleen, 141 gm., congested, friable. Liver, 567 gm., congested. Duodenum and small bowel congested, latter contained many ankylostomata and taeniae. Glands enlarged and oedematous; mesenteric and lumbar chocolate coloured, cervical haemorrhagic. Slight pericarditis, fluid in pericard. Fatty degen. of heart. Patchy congestion of lungs. Brain slightly congested. Bone marrow, dark red.	..

SECOND PASSAGE

Exp. XVII Native puppy.	October 22 Rat. Exp. IX Intraperitoneally 1 c.c. of blood. Many parasites seen. Strain Horse I.	October 25 A few seen. Incubation, three days.	Never absent, numbers gradually increased up to death.	Remittent after appearance of parasites. Sudden fall from 103° to 96° F. before death.	November 10 Died. Duration, nineteen days.	..	..	Clear serous fluid in abdomen. Spleen few small recent superficial infarcts, otherwise normal. Peribronchial glands not enlarged, all other glands enlarged, oedematous. Medulla of all dark brown. One mesenteric markedly haemorrhagic. Pericardium distended with blood-stained fluid. Some fluid in pleurae.	..

HUMAN TRYPANOSOME

INOCULATIONS IN DOGS

SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites seen per field	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P. M. Appearances	Remarks
Exp. XXIX Small puppy. ♀	December 23 R.C. Exp. XXVII Intraperitoneally 2·5 cc. of blood. One parasite seen. Strain Guinea	Parasites not seen up to January 2.			January 2 Accidentally killed				
Exp. LVII Small puppy. ♀ Weight, 1,24[illegible] gm	January 6 R.C. Exp. XXVII Intraperitoneally 2·5 cc. of blood. Six parasites seen. Strain Gambia	January 22 Less than 1 per field on January 18, 1,500 per field on January 19, 2,000 per field on January 20, 3,940 per field on January 21, 5,940 per field on January 22	Present fr. January 22 to April 11 Present for seven days Absent for eight days Discontinued up to April 11 Never numerous, at most four seen.	After appearance of parasites temp. 1·4° to 2·5° F. March 31–April 11 temp. normal	May Developed	No changes.	Exp. LXXIII.		Health unaffected. By April 11 was well grown. Sent to England.

THIRD PASSAGE

Exp. XLV. Small puppy. ♀ Weight, 2 kgs.	December 8 R.C. Exp. XXXIX Intraperitoneally 2 cc. of blood. Never seen per field	December 29 2 cc. of blood, centrifugalized. Five parasites seen. Blood negative up to December 24.	Never seen up to February 1, after seven days. Present for six days. Dates of March and April films found. Absent to date	As in Exp. LVII. End of April temp. even, 1·4° F.	August 31 Still alive.	No changes.	Exp. CLXXXVII. (Never infected.)		Is now a large strong dog
Reinoculation	December 23 Same as above. Intraperitoneally 2 cc. of blood. Ten parasites seen. Strain Lukuga								

INOCULATIONS IN GOATS — **FIRST PASSAGE** — IX

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.M. Appearances	Remarks
Exp. X Brown gelded goat about one year old	October 15 Horse I Intraperitoneally 5cc.c. of blood. Numerous parasites seen.	October 18 One parasite to coverslip. Incubation, three days.	Up to October 31, rarely seen and only in small numbers. Absent since October 31.	Rose on appearance of parasites, 1.5° F.; afterwards very irregular. Occasional pyrexia for one to two days, 106° F.	August 31 Still alive.		Exp. LXVII. Exp. LXVIII. Exp. XCVI.		No signs of illness, Rat, Exp. XCVI, inoculated five months after appearance of parasites, became infected, as also Rat, Exp. LXVII.

THIRD PASSAGE

Exp. XXXV Grey goat, about one year old. ♂	November 28 Guinea-pig, Exp. XXII Intraperitoneally blood and spleen juice. Many parasites seen. Strain Horse I.	December 1 One parasite to coverslip. Incubation, four days.	Present with intermissions for three and a half weeks after inoculation. Never numerous.	After first two months occasional pyrexia for one to two days.	August 31 Still alive.		Exp. XCVII.		Inoculated at P.-M. of guinea-pig, XXII. Rat Exp. XCVII became infected.

HUMAN TRYPANOSOME

INOCULATIONS IN GOATS

SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. CXLIV Small goat.	July 31 Rat, Exp. XXXVII Intraperitoneally 5 c.c. of defibrinated Blood Few parasites to field. Strain Gambia.	Never became infected.			August 31 Still alive.		Exp. CLXXXV.		

THIRD PASSAGE

Exp. XLVI Kid about three months old.	December 8 Rat, Exp. XXXIX Intraperitoneally 5 c.c. of blood. Nine parasites seen. Strain Lamun.	January 7 Eight parasites seen in centrifuged blood. Up to December 26 daily examinations revealed no parasites.	Parasites very scarce; only occasionally seen. Absent from February 26.	Rise of temperature to 106° F. usually coincided with appearance of parasites. March 29, 106° to 107° F.	April 12 Died. Duration, 125 days.	No obvious change.		No. P.-M., carcase too decomposed.	Died while away. Increased in weight for first two months. From March 29 became emaciated.
Exp. CXI Adult goat.	April 2 Rat, Exp. XXXIX Subcutaneously 1 c.c. of blood. One parasite to three fields. Strain Lamun.	Absent up to April			May (about third week) Died.		Exp. CXIX. Exp. CXX. Exp. CXXI. Exp. CXXII At P.-M.	Spleen 610 gms. Organs normal. Glands enlarged. Glands along œsophagus and rest of neck soft with chocolate coloured centres; some small ones dark brown. In mesentery few small completely haemorrhagic glands, size of peas. Along iliac arteries large glands either haemorrhagic or chocolate coloured. Brain slightly congested.	Animal inoculated just before being sent to England. Died soon after landing in Liverpool.
Exp. CX Adult goat.	April 2 Horse, Exp. LXXXVII Subcutaneously 4 c.c. of blood. Two parasites to field. Strain Mr. Q.	July 7 3 c.c. of blood centrifuged. Few number seen.			August 31 Still alive		Exp. CLXXXVI	..	Goat appeared to be thinner on July 7.

INOCULATIONS IN BOVINES

SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. XX Small native calf. Six months old.	October 28 Rat. Exp. IX 0·5 c.c. of blood. Numerous parasites seen. Strain Horse I.	November 6 Parasites scanty at first, increasing to 1 in each field. Incubation, nine days.	Very few	October 30, rose to 103·8° F.; fell next day. November 4 to 6, elevated. Again on November 8. Slight rise November 15.	November 17 Died. Duration twenty days.		Exp. XXV.	See P.-M. Report, page 48.	Very thin before death.

FOURTH PASSAGE

Exp. XLVIII Adult native bullock.	December 24 Rat. Exp. XXXVIII Subcutaneously. 0·5 c.c. of blood. Many parasites seen. Strain Horse I.	January 5 Very few after centrifuging. Incubation, twelve days.	Very few. Usually 0·5 c.c. of blood contained only three parasites.	Up to January 12 never above 102° F. January 22, 105° F., for two days.	February 2 Died. Duration forty days.		Exp. LXXVII.	See P.-M. Report, page 49.	Became thin towards end. No other symptoms observed.

INOCULATIONS IN NATIVE SHEEP

THIRD PASSAGE

Exp. XXXVI Native sheep. Six months old.	November 30 Rat. Exp. XVIII Intraperitoneally 0·5 c.c. of blood containing 0000 parasites per c.mm. Strain Horse I.	December 8 Eight parasites. Incubation, eight days.	Fairly numerous on Dec. 10, 11, 12. Few but constantly present to Jan. 7. Absent up to end of April.	Sharp initial rise to 107·2° F., coinciding with appearance of parasites. Later, very irregular; occasional pyrexia, 105° to 106° F.	May (third week) Died. Duration over 182 days.			Too decomposed.	Animal shipped to England, died on way. Up to end of April no symptoms observed.

HUMAN TRYPANOSOME

INOCULATION IN HORSE

SECOND PASSAGE

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Number of Parasites usually seen and periodicity	Type of Temperature Records	Result Date of Death	Changes in Blood	Subinoculations	P.-M. Appearances	Remarks
Exp. LXXXVII Young bay stallion.	1 c.c. artery of Rat. Exp. LXIX. Sub-cutaneously in the cellular tissue at base of left ear with 5% rat blood, shewing no forms, traps, to field. *Note.*—Horse's blood previously examined by centrifuge and by inoculation into two rats which have never become infected. Strain Mr. Q.	Parasites were not seen up to March 4. After our return from Makaroff on March 10, blood howed on parasite to field. Interval between March 4 and March 10.	Parasites seen fairly constantly from March 10 up to the time horse was shipped home last week in May. They were never numerous. Absent from July to Aug. 31.	See Chart.	August 31 Still alive.		Exp. XCV a. Exp. XCV b. Exp. CX. Exp. CXL. Exp. CXLI.		On return from Makaroff horse looked unwell, drooping its head. There was noticed a slight opacity on left cornea and a watery discharge from both eyes with slight injection of conjunctival vessels. The opacity of cornea cleared up in about three weeks. Horse was decidedly thinner by the end of March, ribs showing slightly. No œdema ever seen. The animal improved on the voyage home; it is now in fine condition, though its blood is infective to rats.

EQUINE TRYPANOSOME

INOCULATIONS IN FOWLS

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Result Date of Death
Exp. XXI White hen.	October 28 Rat. Exp. IX Intraperitoneally 1 c.c. of blood containing numerous parasites.	Never became infected.	August 31 Still alive.
Reinoculation	December 16 Rat. Exp. XXXVIII 1 c.c. of blood showing many parasites.		
Reinoculation	February 17 Rat. Exp. LXVII 1 c.c. of blood containing numerous parasites. Strain Horse I.		

Animal	Date, Source, and Mode of Inoculation	Date of Appearance of Parasites in the Peripheral Blood	Result Date of Death
Exp. XXXIV Black hen.	October 28 Rat. Exp. IX Intraperitoneally 0·5 c.c. of blood rich in parasites.	Never became infected.	January Accidentally killed.
Reinoculation	December 16 Rat. Exp. XXXVIII With 1 c.c. of blood. Strain Horse I.		

Note by Dr. H. E. Annett

The Results of Inoculation of Blood from the European Case, H.K.

(*vide* p. 9)

Tame Rats.—White, black and white. Injected intraperitoneally with about 0·2 c.c. peripheral blood diluted with normal saline solution; in some twenty-five per cent. only was it possible to demonstrate parasites. The parasites first appeared in the peripheral blood in from fifteen to twenty-five days after the inoculation, and their presence continued for three or four days, apparently without any significant rise in temperature. The animals lived for periods varying from two to four months or longer, and occasionally only during this time could parasites be found. Usually on *post-mortem* examination they also seemed to be absent, in occasional instances only were they present in the heart's blood.

Tame Mice.—White, brown, black, etc. Parasites were never seen after injection.

Rabbits and Guinea-Pigs.—Seemed to be refractory.

Monkeys (*Rhesus*).—Seem to be all susceptible to intraperitoneal infection. Parasites can be demonstrated in the peripheral blood only after the twelfth day after infection, their first appearance being preceded by a rapid rise in temperature, followed by a more gradual fall during the next three days. The number of parasites per cover-glass preparation varied during this period from eight to ten in number, occasionally more, and then gradually disappeared. A similar phenomenon occurred at intervals of five to ten days, the animal gradually losing weight until death occurred in from six weeks to three months. In one case, *post-mortem*, numerous parasites were seen, but in others none were found.

Monkeys were inoculated at different periods during the time which K. spent in England, including two inoculations with blood two days before death, one of which died after three months' infection; the other shewed few parasites at times, and appeared very ill and emaciated on two occasions, but eventually recovered, and now, after a period of nine months, is healthy, and no parasites can be found in blood, either microscopically or by inoculation into rats.

In monkeys no such symptoms as are described in human cases occur, beyond the occasional rises in temperature (during which parasites are present in peripheral blood) and the emaciation.

Notes on Post-Mortems of Experimental Animals

Experiment XVIII

Post-Mortem of Guinea-Pig

Autopsy.—Died during the night. Body emaciated, some slight yellow-coloured fluid in pleural and peritoneal cavities, slightly turbid in the latter.

Heart.—Normal; right side contained a dark blood clot.

Lungs.—Showed patchy congestion marked in right lower lobe, otherwise normal.

Liver.—Large, and slightly congested.

Spleen.—3·5 x 1·5 x 0·4 cm. Slightly injected.

Stomach.—Some congestion along greater curvature.

The *duodenum* for about 3 cm. was much thickened and deeply congested; about 1 cm. from pylorus it was adherent to liver and a coil of small intestine. In this situation three ulcers were found, one large, with a sloughy base; this had almost perforated. In small gut Peyers patches were slightly thickened and inflamed.

Kidneys.—Slightly injected.

Lymphatic glands.—On both sides the superficial and deep inguinal glands, though only slightly enlarged, were crimson in colour ; the smaller ones appeared like rounded bits of blood clot ; in the larger ones, the cortex in places was pale. Similar glands were present in axilla and in neck, but were not so haemorrhagic. Mesenteric, lumbar, and pelvic glands were slightly enlarged, some smaller ones haemorrhagic. The larger ones were deeply injected in places. Bronchial and sternal glands were slightly enlarged and injected. No parasites seen in the blood from heart or lungs.

Experiment XXVII—

Post-mortem of Rat.

Rat died during the night. The body was emaciated and covered with lice. Incisor teeth were absent from the upper jaw (decay). No fluid in pleural and peritoneal cavities.

Lungs.—Slightly congested, but perfectly healthy.

Heart.—Normal.

Liver.—Pale, studded with small white punctate spots.

Spleen.—Enlarged and congested, 6·5 × 1·7 × 1·0 cm. A small infarct present on outer surface three mm. in diameter, did not extend deeply into tissue.

Kidneys.—Apparently normal.

Lymphatic Glands.—Superficial inguinal and axillary slightly enlarged and congested. Bronchial glands were enlarged and deeply injected.

Abdominal glands small, not injected. Mesenteric slightly enlarged, not injected.

Brain.—Slight injection of pia.

No parasites seen in heart blood at P.-M.

Remarks.—The death of this rat was probably in a great measure due to old age, hastened by the loss of the incisor teeth.

Experiment XX—

Post-Mortem of Native Calf

Autopsy.—Very slight subcutaneous oedema in tissues over thorax. Abdomen contained a small amount of slightly bile-tinged fluid.

Liver.—Dark, friable ; gall bladder full of dark, viscid bile.

Spleen.—Enlarged ; substance soft, congested.

Lymphatic glands.—Mesenteric glands immediately adjacent to small intestine much enlarged. Some the size of a pigeon's egg. On section medulla is dark brown in colour, glands surrounded by a gelatinous, almost colloid, oedema. In great mesentery, and also accompanyng the above large glands, were other smaller completely haemorrhagic glands varying in size from a hemp seed to a pea. Some of these were so full of blood as to be diffluent. Iliac and lumbar glands much enlarged and soft, with surrounding oedematous tissue above described. Bronchial and cervical glands were similarly oedematous, many were completely haemorrhagic. Veins of kidneys, mesentery, and heart generally surrounded by yellow gelatinous oedema.

Marrow, of short bones, was normal in appearance ; of long bones, yellowish and gelatinous, with here and there decidedly reddened areas.

Heart.—Muscle pale and firm.

Lungs.—Normal.

Experiment XLVIII

Post-Mortem of Native Bullock*

Performed immediately after death. Some ten unidentified adult filariae were found in conjunctival sacs of both eyes. No sores nor discharge from nostrils. On section no oedema of abdominal wall. Stomachs enormously distended with food ; small intestines empty.

Liver.—2·72 kilogrammes. Substance dark. On upper surface of right lobe was a superficial abscess the size of an acorn, which contained a small slough. The abscess was quite localized. Gall bladder full of light-green fluid bile. Dotted over surface of mucous membranes were small circular injected areas.

Spleen.—Weight, 793 grammes. Vessels of capsule injected, substance normal.

Kidneys.—Right, 510.2 grammes ; left, 453·6 grammes. Appearance, normal. The perirenal connective tissue was infiltrated with a yellow gelatinous oedema. Pancreas and suprarenals apparently normal.

Lungs.—Left, upper lobe firmly bound down by old adhesions, substance normal. Right, lower and middle lobes deeply injected. On section patchy, recent consolidation present.

Heart.—Slight amount of straw-coloured fluid present in pericardial sac. Valves, normal. Muscle, normal. Some gelatinous oedema along coronary arteries. Fat, abundant.

Bone marrow of long bones, yellow ; of short bones, dark red.

Brain.—Slight thickening and injection of the pia mater.

Lymphatic Glands.—The same appearances were seen as in P.-M. of Experiment XX.

Once more the most marked pathological changes observed were in the lymphatic glands. Many very small, entirely haemorrhagic glands, varying in size from a pea to a bean, occurred in the mesentery. All the lymphatic glands were enlarged and oedematous. The medullae of many were of a deep chocolate colour, and some of the retroperitoneal group were markedly haemorrhagic.

* The thanks of the Expedition are due to the Gambia Government, who kindly supplied the animal used in this experiment.

VII. OTHER FORMS OF FLAGELLATA FOUND IN SENEGAMBIA

In the course of our examination of a large number of small animals and birds, we observed some ten varieties of flagellates, for the most part belonging to the family *Trypanosomidae* (Doflein). These organisms occurred in the blood of frogs, small birds, tortoises, and in the African house mouse.

We were not able to make any serious attempt to ascertain the life history of these parasites. It is probable that a study of the trypanosomata, parasitic in lower animals, will throw light on obscure points in the life history of those species pathogenic to man and the higher animals. Such a study, in the case of other parasites, has met with most fruitful results, notably so in malaria. For this reason, we here present a short description of the forms we have seen in fresh blood, and of their appearance in film preparations, stained by Romanowsky's method.

Trypanosomes in Frogs

Trypanosoma sanguinis, Gruby,[35] 1843.

A parasite was frequently seen in the blood of African frogs corresponding to that first described by Gruby in 1843, and called by him *T. sanguinis*. Out of twenty-nine frogs examined, including *Rana trinodis* (?) and other species, this parasite was seen in the blood of fourteen. The parasites were never encountered in any great numbers in either the peripheral or central circulations of the infected frogs. At the most four to six were seen in a preparation.

This parasite has been described in the living state by Ray Lankester[43] as a minute pyriform sac, with the narrower end bent round on itself somewhat spirally, and the broader end spread out into a thin membrane which is produced on one side into a very long flagellum. The wall of the sac was striated coarsely as in *Opalina*, and the direction of the striae on the two sides of the sac, as seen one through the other, showed that the small end of the sac was twisted as well as bent over on itself. A pale clear nucleus and a very few granules were also seen. In life, the broad membrane undulates vigorously in a series of waves, the flagellum taking part in the movements. The series of waves of the undulating membrane are not incessantly in one and the same direction. In stained preparations (Romanowsky method) the simplest form of the parasite seen is represented in Plate II, fig. 3.

This parasite differs from other trypanosomes seen in frogs, in that there is no definite line of demarcation between the body proper and the undulating membrane. The protoplasm of the body takes on a deep bluish purple tint

and is arranged in bands in the long axis of the body. These bands commence at the blunted end of the organism as fine streaks which gradually increase in thickness towards their centre and then fade away into the undulating membrane. In the simplest form of this parasite there are one or two such bands. The posterior end (the end remote from the flagellum) is round and blunted, and is occupied usually by a comparatively large unstained area. The undulating membrane is broad; it commences 8 μ from the posterior end and extends along the base of the cone-shaped body, gradually decreasing in width. There is a general bluish mottling at the base of the undulating membrane. The flagellum runs along the undulating membrane, its free part extending for about 8 μ to 10 μ from the anterior extremity of the body. It is an extremely fine filament and does not stain well by ROMANOWSKY'S method. The micronucleus is seen as a crimson dot from which the flagellum arises; it is situated near the centre of the body and is often difficult to make out. By careful focussing with a $\frac{1}{12}$" oil immersion a small, red-stained, rounded area can be made out either beneath or above the macronucleus, as the case may be. It is often obscured by the dark stained bands of the protoplasm above described.

Besides this simple form of the parasite there are other larger forms which differ from it in the following manner :—

(*a*) The posterior end of the organism is toothed. Three such ridges have been generally encountered in these forms.

(*b*) Instead of one or two there are generally three to four longitudinal bands of deeply staining protoplasm, which commence in these ridges and proceed, often in a spiral manner, towards the undulating membrane. Before their termination they generally present an unstained area. It would appear that these bands are slightly raised from the surface of the parasite. This may account for the striated appearance seen in the fresh state. In these larger forms the micronucleus and macronucleus are generally obscured by the darkly-stained bands.

In stained preparations the average length of the parasite, excluding the flagellum, is 27 μ, its width opposite the micronucleus is 3·2 μ, and the width of the undulating membrane at this point in specimens of the type shown in Fig. 3 is 4·5 μ. LAVERAN and MESNIL* have already described this trypanosome as they observed it in stained specimens of blood taken from European green frogs.

Trypanosoma mega.—New species (Provisional), Plate II, fig. 4.

Many large trypanosomes, three to six in a coverslip preparation, were seen in the blood of a small frog, caught in a marsh at McCarthy Island, in January.

Progressive movement was rather sluggish in these organisms, and was evidently brought about by contraction of the body protoplasm, as well as of the undulating membrane. Both ends of the organism tapered for some distance into a long fine

* Laveran et Mesnil, [illegible] *Comptes Rend. Soc. Biol.* Paris, v. 53, p. 23, June 22, 1901.

process, which at one end was continued on as the free portion of the flagellum. The undulating membrane commenced at a highly refractile spot, surrounded by an area also refractile and situated about one-third of the body's length from the posterior non-flagellated end. The protoplasm has a coarsely granular appearance, and differed in structure in the anterior and posterior portions of the body.

The parasite progresses generally with the flagellum in advance. When stationary, waves of motion move in either direction up and down the undulating membrane.

In stained preparations, the parasite did not vary in form to any appreciable extent. The width in some few specimens was slightly less than in the majority. The shape of the body is seen in Plate II, fig. 4. The protoplasm stains very deeply blue with Romanowsky's stain. The portion (anterior two-thirds) of the body to which is attached the undulating membrane is longitudinally striated, to a marked degree, with dark and light bands. The spongioplasm of this portion is closely arranged, and its hyaloplasm stains more deeply than that of the posterior third of the organism. With careful focussing it is seen that the light unstained bands are raised from the surface of the parasite. If this part of the body of the organism is twisted on itself, a trellis-work appearance is brought about by the crossing of the light stripes. The anterior two-thirds of the body ends abruptly at the macronucleus, from which it is separated by a narrow unstained area, probably due to a retraction of the protoplasm caused by the drying of the film. The light bands are continued on past the nucleus to the base of the posterior portion. The protoplasm of the posterior portion of the body has a very spongy appearance, and presents a contrast to the anterior. This appearance becomes more marked as the posterior extremity of the parasite is reached. With careful focussing a fine superficial striation can be made out.

In the process of smearing the frog's blood on a slide some of these large parasites were injured. From a study of such specimens it can easily be made out that the body of the parasite is enclosed in an outer membranous covering, which on one side is prolonged as the undulating membrane,* along the free border of which the flagellum is attached. In one parasite this membrane was partially stripped off and stained a faint reddish purple colour. In it were seen fine pink staining lines, having a looped arrangement and apparently running round the short axis of the organism. The membranous envelope is much more easily seen in the anterior division of the parasite. The undulating membrane commences opposite the nucleus as a comparatively wide fringe which is thrown into folds and takes on a faint purple tint. It gradually narrows towards the anterior end. Along its free border is attached the flagellum, staining a reddish pink. The latter commences at the micronucleus and ends anteriorly as a free filament. The macronucleus is situated

about 28 μ from the posterior end; it is finely granular, is coloured light crimson, and extends completely across the short axis of the parasite. The micronucleus is in close proximity to the macronucleus, though separated by a slight interval. Its position on an average is 26 μ from the posterior end of the organism. It stains a deep crimson, is devoid of structure, and is surrounded by a zone staining light blue. The average length of a parasite as measured in stained preparations is 72 μ. This excludes the free flagellum, which is from 10 μ to 15 μ long. The width of the parasite at the macronucleus is 8 μ.

The frog infected was eventually killed, and preparations of blood taken from various parts of the body were examined. Parasites were seen in all, and were not found to be particularly numerous in the preparations from any one organ. No forms were seen in developmental stages. No parasites were seen in the peritoneal fluid. The organs of the frog appeared normal macroscopically.

Trypanosoma Karyozeukton.—New species (provisional).

In a stained (Romanowsky) preparation of the blood of a frog (sp. ?) caught at Cape St. Mary, Gambia, October 23, in a fresh preparation of which *T. sanguinis* had been seen, one specimen of a large trypanosome (Plate II, fig. 5) was encountered presenting the following characteristics.

Length, excluding the flagellum, 67·2 μ. Width at macronucleus, 6·4 μ. Distance from micronucleus to centre of macronucleus, about 16 μ. Distance from micronucleus to posterior extremity, 9·8 μ. Length of free flagellum, 15·2 μ. As in the preceding trypanosome, the body protoplasm posterior to the macronucleus presents a contrast to the anterior portion. The former does not stain so deeply and has a mottled appearance. The latter stains more deeply, has a much more closely arranged spongioplasm, and in it faint longitudinal striation can be made out. The micronucleus is ovoid, stains a dark crimson, and shows no structure. The macronucleus extends the whole width of the organism and takes on a light crimson colour. Its structure cannot be made out. Posterior to the macronucleus are scattered, for a short distance in the protoplasm, fairly large granules, staining a deep bluish-purple colour. Between the micronucleus and macronucleus runs a chain of small red oval granules, which are, apparently, of the same nature as chromatin. Examination with a $\frac{1}{12}$" oil immersion has not enabled us to say definitely that there is a union between the macronucleus and micronucleus by means of this chain of chromatinic granules. The posterior end of the parasite gradually tapers to a fine filament. Posterior to the micronucleus the narrowing becomes more marked. The undulating membrane commences opposite the micronucleus and runs along one side of the organism as a narrow band. It is stained faintly pink.

Three other frogs were received at the same time as that which harboured the trypanosome just described; in the blood of two of these were seen an

actively motile, long and thin trypanosome. There were two to three of these parasites to a coverslip preparation. The movements of the parasite were so energetic that it was difficult to obtain an idea of its structure in the fresh state. The undulating membrane was seen to extend nearly the whole length of the parasite, and by its rapid screw-like movements to cause the organism to move in a spiral manner in and out among the red cells.

In stained preparations the average length of the parasite, excluding the free flagellum which is seen with difficulty in many specimens, is 56·8 μ. Its width at the macronucleus is 3·5 μ. The distance between the micronucleus and the centre of the macronucleus is on an average 6·5 μ. Measurements taken from the tip of the posterior end of the body to the micronucleus averaged - μ.

Though this parasite is much smaller than the larger parasite just described, the relation of the micronucleus to the macronucleus and the relative sizes of the flagellum bearing and posterior portions of the body lead us to believe that it belongs to the same species. The following resemblances are noteworthy with regard to the structure: The smaller parasite has the same feebly staining macronucleus extending the whole width of the organism, and the same oval-shaped micronucleus as the larger form. The undulating membrane is comparatively narrow as in the larger parasite. The most noticeable structural difference between the two parasites is that in the smaller one it is the portion of the body anterior to the macronucleus which is more markedly striated. Other differences are as follows: —The striae in the smaller parasite appear as longitudinal white lines broken at fairly even intervals. It has no granules posterior to the macronucleus and no chromatinic dotted line between micro- and macronucleus. It is possible that the larger parasite may represent an early stage of reproduction.

Trypanosomes in Tortoises

Two tortoises obtained from the marshes at Cape St. Mary, out of several examined, contained trypanosomes in their blood. Their blood was constantly examined during a period of three months, but only occasionally were parasites seen, and then only in small numbers. Two varieties were observed. One was a long thick form, the other, short and slender, possessed a comparatively broad undulating membrane which extended the whole length of the organism.

The few parasites seen in stained films of blood from these tortoises have not been sufficiently perfect to permit their detailed description. Our notes on their morphology are therefore reserved until further material is obtainable.

Trypanosomes in Birds

Trypanosoma johnstoni. New species.

This trypanosome was found in the blood of a species of small bird (*Estrelda*

estrelda) very common in Senegambia. One was found to be infected out of twenty-five birds of different species, for the most part belonging to genera *Estrelda* and *Crithagra*, examined in the laboratory in August. These birds came from Bathurst, Gambia, whence they had been sent in May.

Only two to four parasites were seen in a coverslip preparation. In fresh preparations the parasite appears as a very actively moving spirillum-like body; so striking, indeed, is this resemblance, that at first sight it was thought to be a true spirillum. The undulating membrane is scarcely recognizable, and the parasite has no free flagellum. When its movements have become slower, the organism is seen to possess a long straight body pointed at both ends. At a point about one-third of its length distant from the posterior end of the parasite is seen a refractile spot, the micronucleus. A little further on, a slightly refractile area indicates the position of the macronucleus. When the parasite is stationary for a moment, waves of movement commencing at the anterior end travel down to this refractile area and there cease. The part of the body posterior to this spot remains perfectly quiescent. The parasite generally moves with the end remote from the refractile spot in front. Careful examination reveals the presence of a very narrow undulating membrane, commencing at the micronucleus and running along to the anterior end of the organism. No free flagellum could be made out in fresh specimens. The protoplasm of the organism was apparently homogeneous.

In stained preparations, Plate II, fig. 1, the above details are better seen. Along the free border of the undulating membrane runs the flagellum, stopping abruptly at the anterior end of the organism in a small red dot. The macronucleus is elongated, granular, and does not quite extend across the short axis of the parasite. The micronucleus is a small dot or oval spot of chromatin surrounded by a small halo. The protoplasm takes on a uniform blue colour. The length of the parasite varies from 36 μ to 38 μ, and its width at the macronucleus is 1·4 μ to 1·6 μ. The distance from the micronucleus to the posterior end is 10·4 μ. Distance from the micronucleus to the centre of the macronucleus is 9 μ to 10 μ. No developmental or dividing forms were seen in any preparation.

Two larks were inoculated, each with 0·5 c.c. of blood from this bird, but so far parasites have not been seen in the blood of either.

Trypanosoma.—Spec. incert. This parasite was fairly common in the blood of species of *Crithagra* and *Estrelda*, both at St. Louis and Bathurst, though they were never present in large numbers.*

At St. Louis out of fifteen birds examined seven were infected.

At the most three to six parasites were seen in a preparation. In the fresh film the parasite is a very stumpy organism which moves sluggishly in the blood.

* [illegible] coral, cordon bleu, ventre rouge. The majority of the birds examined were of the first.

The width is great in proportion to the length of the body. The protoplasm has a very granular appearance. At one end is seen a highly refractile spot, at the other a fine, free flagellum. Both ends of the parasite are stumpy.

In stained preparations, the parasite generally assumes an oval shape, due to its stumpy anterior and posterior ends and to its great width. The protoplasm takes on a deep blue reaction, is longitudinally striated, and is marked with one or two lighter patches in front of the macronucleus. The micronucleus is a large crimson spot. It is situated at the posterior end of the parasite and is in close relation to a clear space, a vacuole. The macronucleus is situated centrally and extends across the middle of the body. It stains a pink red colour, the chromatin being diffuse. The undulating membrane is a very narrow band extending on one side of the parasite from the micronucleus to the anterior end of the parasite's body. In Plate II, fig. 2 the undulating membrane has the appearance of crossing over the body; this is due to the parasite being twisted on itself. The flagellum commences in the micronucleus, runs along the free border of the undulating membrane and ends as a fine free filament. Length of the parasite without free flagellum is 21·6 μ. Its width opposite macronucleus is 8 μ. The distance from micronucleus to centre of macronucleus is 9·6 μ. The length of the free portion of the flagellum is about 10 μ to 12 μ. No divisional forms were seen.

Two pigeons and two larks have been inoculated with these parasites, but have not yet shown organisms in their blood. The pigeons were inoculated three months ago.

Dr. Hanna has very kindly shown us specimens of a trypanosome which he found in a pigeon in India, and we have also been able, through the kindness of Major Ross, to see one or two slides of blood taken from a blue jay in India, containing filariae and trypanosomes.

These will shortly be described and illustrated by Dr. Hanna; they present several morphological differences from the parasite we have seen in Africa. We feel certain that many more of these parasites will be found in birds and small animals both in India and Africa.

Danilewsky* has described two varieties of trypanosomes—*Trypanosoma major* and *Trypanosoma avium*—observed in the blood of birds. Unfortunately, we have not been able to obtain his original paper, and the reviews, which we have seen of his works, have not been sufficiently definite to enable us to determine whether our second *avian trypanosome* is the same as his or not. We have, therefore, left it unnamed for the present.

Flagellata in the Blood of a Mouse

At McCarthy Island, we obtained a few house mice and some field mice (Spec. unknown).

* La parasitologie comparée du sang. *Nouvelles recherches sur le parasitisme du sang des oiseaux*, 1889.

Fourteen of the former in all were examined, and in the blood of three, flagellated protozoa were seen. Twenty field mice were examined, but none were found to be infected. The organism occurred infrequently in the blood of the mice infected, and we never saw more than one or two parasites in a fresh coverslip preparation.

The organism was striking, in that it presented characteristics which differentiated it, at a glance, from a trypanosome. It consisted of a long oval-shaped body with blunt rounded ends, to one of which a very long flagellum was attached. At this end the body tapered slightly. A glance showed that the long flagellum, slightly longer than the body, was the chief organ of locomotion. It acted as a tractellum, and obviously dragged the body of the parasite after it. On encountering an obstruction the flagellum lashed out in all directions, hurled the red cells behind it, and often twisted round, so that its tip reached past the posterior end of the body. On these occasions, it was easy to examine the structure and measure the length of the parasite, as the body was perfectly quiescent. The protoplasm has a slightly granular appearance and in its substance, placed a little in front of the centre and towards the flagellated end, is a collection of refractile granules. About 5 μ from the anterior end is seen a highly refractile spot from which the flagellum takes origin. No suggestion of an undulatory membrane was seen. The length of the body in the living condition is 20·8 μ, and its greatest width 3·2 μ. The body of the parasite sometimes assumed an 'S'-shaped form, on account of external pressure or rapid changes of direction of movement, but no active contractions of the protoplasm were seen.

Unfortunately, two mice sent home infected with this parasite died on the voyage, and in the films made from the mice while in Gambia, no specimens have been seen. A small rat inoculated from one of the mice has not shown the parasite in its blood. No symptoms were observed in the mice infected.

This parasite resembles very closely *Herpetomonas* (*Leptomonas*) *Butschli* (S. Kent). The figures given of this organism correspond very closely with our flagellate, except that in the mouse parasite there is not the marked tapering of the non-flagellated end of the body. *Herpetomonas Butschli*, however, inhabits the intestinal tract of *Trilobus Gracilis*, and not a vertebrate circulatory system.

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We have added to our report therefore, a list of only some of the more recent publications. We hope that it may prove useful.

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APPENDIX

A NEW CULICID FROM SENEGAL AND NOTES ON THE SPECIES OF MOSQUITOES, ETC.

By F. V. THEOBALD, M.A.

Amongst a large collection of mosquitoes and other biting-mouthed diptera collected and bred by Drs. Dutton and Todd during their recent expedition to Senegal, is a large series of a new Culicid, resembling in habits the *Deinocerites cancer*, Theobald, of the West Indies. It comes very near my genera *Stegomyia** and *Macleaya*,† but cannot be placed in either. Without an examination of the scale structure, one would certainly place it in *Culex*, but hasty microscopic examination shows it to come much nearer the two first-named genera. I propose for it the generic name *Catageiomyia*, (κατάγειος, subterranean, and μυῖα, a fly).

Genus *Catageiomyia*. Nov. gen.

Head covered with rather irregular loosely-applied flat scales, a few narrow-curved ones on the nape in the ♀, spreading rather further on to the occiput in the ♂, also with numerous narrow, upright, forked scales. Palpi short in the ♀, composed of three segments, the last one as long as the two basal ones; in the ♂ the palpi are long, but not nearly as long as the proboscis, the two apical joints short, the apical one slightly shorter than the penultimate, the apex of the antepenultimate slightly expanded, dense hairs on each side of the penultimate and on one side of the apex of the antepenultimate; apex bristly. Thorax with narrow-curved scales on the mesonotum; small flat ones on the mid lobe of the scutellum; narrow-curved ones on the lateral lobes.

This genus thus differs from *Stegomyia* in (1) having narrow-curved scales on the back of the head, (2) narrow-curved scales on the lateral lobes of the scutellum; and from *Macleaya* in (1) having the flat cephalic scales more loosely applied, (2) in having the ♂ palpi much shorter than the proboscis.

In general appearance it resembles a *Culex* of the *fatigans* group, but the scale structure, palpi, etc., are quite distinct.

Catageiomyia senegalensis. N. sp.

Thorax rich, deep brown, with small scattered golden scales, paler before the scutellum; numerous long dark bristles posteriorly. Abdomen black, with basal white bands, which spread out laterally; venter, with broad basal white bands; head ornamented, with grey and black; proboscis deep brown, unbanded; legs deep brown, unbanded, except the hind tibiae, which have an apical white band; venter of femora, white. Wings with brown-scaled veins. Male palpi shorter than proboscis.

♀. Head clothed with loosely applied flat scales all over, a few narrow curved ones behind, and narrow upright brown forked ones scattered about; the flat scales are in black and white areas, and the narrow curved ones are pale grey; there are dark brown bristles projecting in front; eyes purple when dead; palpi, brown, three-jointed, the last joint as long as the two basal ones; antennae, brown; basal joint pale testaceous, with grey sheen, and a few small dark scales internally; clypeus and proboscis, deep brown.

* *Memoirs Liverpool*, Vol. I, 1901.

† *Ann. Entom. Soc.*, Vol. XXXVI, p. 154, 1903.

Thorax, deep rich brown with narrow-curved bronzy scales, amongst which are scattered narrow-curved bright golden ones, grey ones in front of the roots of the wings and in front of the scutellum ; numerous long black bristles over the roots of the wings and on the posterior part of the mesonotum ; prothoracic lobes brown with outstanding creamy narrow-curved scales, and a series of stout black orwardly projecting bristles. Scutellum, testaceous with narrow-curved grey scales wider than those of the mesonotum ; on the side lobes, border bristles deep brown in two series ; on the median lobe, six larger ones, and numerous smaller ones behind ; the mid lobe covered with loose flat grey and dusky scales ; pleurae, brown, with patches of grey scales ; metanotum, testaceous brown. Abdomen covered with black scales, the segments with narrow white basal bands which spread out laterally to form spots ; the first segment is pale testaceous at the base with a large apical median patch of black scales, and a few grey ones at the sides, and numerous long brown hairs ; posterior borders of the segments with pale golden border bristles of two alternating sizes ; venter with very broad grey basal bands and narrow apical dark ones.

Legs, deep brown ; bases, paler ; femora, white beneath ; fore and mid legs without any trace of banding, but the hind tibiae have an apical white band and are longer than the hind metatarsi ; femora, tibiae and metatarsi with bristles which are pale golden in some lights, brown in others. Fore and mid ungues equal, uniserrated ; hind, equal and simple.

Wings with the veins clothed with brown scales, rather dense and large on the second long vein and also on the basal areas of all the veins, longish lateral ones on the hind and apices of the fourth and fifth ; first submarginal cell longer and narrower than the second posterior cell, its stem about one-third the length of the cell, its base nearly level with the base of the second posterior cell ; in the second posterior cell the stem is about two-thirds the length of the cell ; posterior cross-vein about one and a half times its own length distant from the mid ; halteres, pale ochraceous.

Length, 4 to 4·5 mm.

♂ Palpi brown, much shorter than the proboscis, the last two joints short, of nearly equal length, darker at their tips than at the base, apex of the antepenultimate joint slightly expanded, also darker than the rest ; traces of a very narrow pale band ; hair-tufts brown ; proboscis deep brown, longer than the palpi ; antennae with flaxen brown plumes, banded brown and grey ; head like the ♀, only rather more narrow-curved scales running into the crown ; thorax and abdomen with similar ornamentation ; fore and mid legs with unequal ungues, the fore both uniserrated, the mid with the large simple, the smaller uniserrated, hind equal and simple ; genitalia with the basal lobe very bristly ; claspers slightly sinuous.

Length.—4 to 4·5 mm.

Habitat.—St. Louis, Senegal (Drs. Dutton and Todd).

Time of Capture.—May and September.

Observations.—Described from a large number of dry and spirit specimens. In habits it bears some resemblance to *Dermocerites cancer* (Theobald). They breed in crab holes, where the larvae were taken as deep down as three feet three inches. The adults were caught in and around the crab holes, in mangrove swamps, near the race course, at St. Louis, also in the bush by Oyster Creek, Bathurst, and in an old tub in a garden at St. Louis.

Culex duttoni.—From old sand garden pool. Sor St. Louis, May 21, 1903. Bred from pool dug in sand to obtain water for gardening purposes, about ten feet deep ; diameter, twelve feet, now disused, now only three inches at bottom. Sor St. Louis, May 22, 1903. Garden tub. Bridge puddle. Bred in laboratory, June 2.

Culex luteolateralis, var. *pallida* (n.v.)—Caught in marsh behind Subenta, January 18.

Culex luteolateralis, var. *albo thorax* (n.v.)—Caught in bush near Inkutu, January 18.

Culex tigripes.—Hatched out from larvae taken in tub, in garden, and in hospital. St. Louis, May 31, 1903. Tub in garden, Sor St. Louis.

New Crab-hole form, n.sp.—Mangrove Swamps racecourse; caught in bush oyster creek; crab-hole and old tub in garden, Sor crab-holes racecourse; taken from crab-hole, three feet three inches from surface, St. Louis.

Culex fatigans, Wied.—St. Louis, north end of island. Garden tubs, St. Louis; hospital garden water-tubs; Sor St. Louis leaky water main. All in May; bred from putrid water, mouth of drain, St. Louis; Sor, taken from pool near leaky water-pipe; bred from putrid water at mouth of old drain, St. Louis. May; Dakar, June 16; Sor, bred from larvae in old native well in sandy pool; from Gorce, June; bred from pupa in puddle, Halftei, September 21, 1902. Cult. F N.

Pyretophorus costalis.—Var. Dakar, June 16, 1903; bred from sand pool, Sor., May 24; Dukai, June 16, 1903; leaky water-main, Sor, St. Louis, May 30; hatched out from discarded pool behind houses, in sand, Sor, St. Louis; hatched from tub and bridge puddle, Khor., June 1.

Stegomyia fasciata.—St. Louis, caught in our house, May 23, bit just as much at night as at day; Goree, June 15, 1903, numbers marked 31 all caught in house at St. Louis; hatched in tub, St. Louis, May 6, 1903; hatched from tub in hospital, St. Louis, McCarthy Island.

Uranotaenia amulata.—Theob. Caught in dry marsh at Dakar, June 13, 1903.

Mansonia uniformis.—Theob. McCarthy Island, June; caught in bush near Sukutu, January 18 (? June).

Plate I

HUMAN TRYPANOSOME

Fig. 1. *Trypanosoma gambiense* in Gambian native. × 2,000.

Fig. 2. *Trypanosoma gambiense* in tame rat. 'Long form.' × 2,000.

Fig. 3. *Trypanosoma gambiense* in tame rat, showing longitudinal division. × 2,000.

Fig. 4. *Trypanosoma gambiense* in tame rat, from a specimen taken one week before death. 'Stumpy form,' showing chromatic granules. × 2,000.

Fig. 5. *Trypanosoma gambiense* in tame rat, from a specimen taken one week before death. 'Round form,' showing granules. × 2,000.

GAMBIAN HORSE TRYPANOSOME

Fig. 6. Horse trypanosome. The small 'tadpole'-shaped parasite in the early stage of the disease. × 2,000.

Fig. 7. Horse trypanosome. 'Stumpy form' in tame rat. × 2,000.

Fig. 8. Horse trypanosome, showing longitudinal division of 'tadpole'-shaped parasite. × 2,000.

Fig. 9. Horse trypanosome. 'Long form,' showing longitudinal division. × 2,000

Fig. 10. Horse trypanosome. 'Long form.' × 2,000.

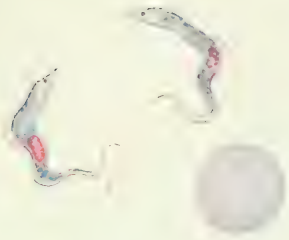


Fig. I.

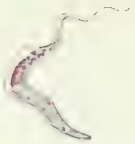
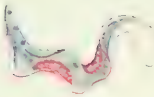


Fig. II.



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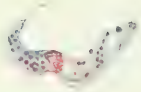


Fig. IV.

Fig. V.

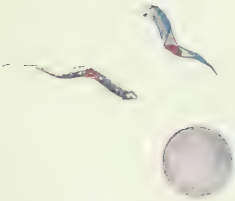


Fig. VI.

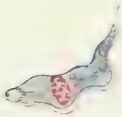


Fig. VII.

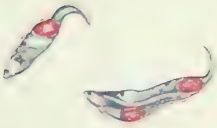


Fig. VIII.

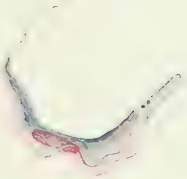


Fig. IX.

Fig. X.

Plate II

TRYPANOSOMES FOUND IN SENEGAMBIA IN THE BLOOD OF BIRDS AND FROGS

In Birds

Fig. 1. *Trypanosoma johnstoni*. Nov. sp. From the blood of *Estrelda astrild*. × 2,000.

Fig. 2. *Trypanosoma*. Sp. incert. Found in the blood of small birds in Senegambia. × 2,000.

In Frogs

Fig. 3. *Trypanosoma sanguinis*. Gruby. The simple form of parasite. × 2,000.

Fig. 4. *Trypanosoma mega*. Nov. sp. × 2,000.

Fig. 5. *Trypanosoma karyozeukton*. × 2,000.

Note the chromatinic chain of granules running from micro- to macronucleus.

Fig. 1

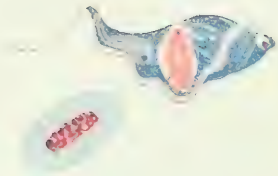


Fig. 2.

Fig. 3.

Fig. 4.

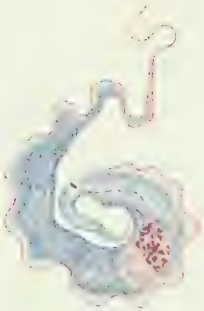


Fig. 5.

Plate III

PHOTOMICROGRAPHS OF HUMAN TRYPANOSOMES

Fig. 1. *Trypanosoma gambiense* in the blood of a native. Case V. 840.

Fig. 2. *Trypanosoma gambiense* in rat. 'Long form.' 840.

Fig. 3. *Trypanosoma gambiense* in rat. 'Stumpy form.' 840.
Note few chromatic granules in parasite situated anterior to the macronucleus.

Fig. 4. *Trypanosoma gambiense*, from the blood of a rat, one week before death. Exp. XXVII. 840.
Note marked chromatic stippling of the protoplasm of the parasite.

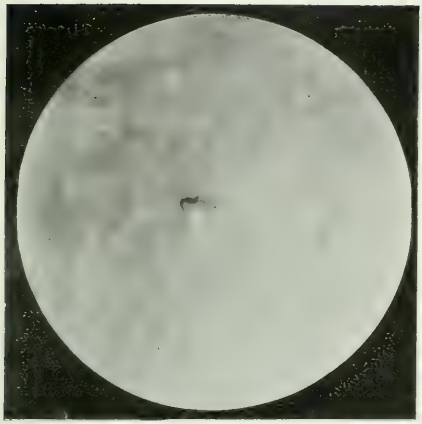


Fig. 1

Fig. 2

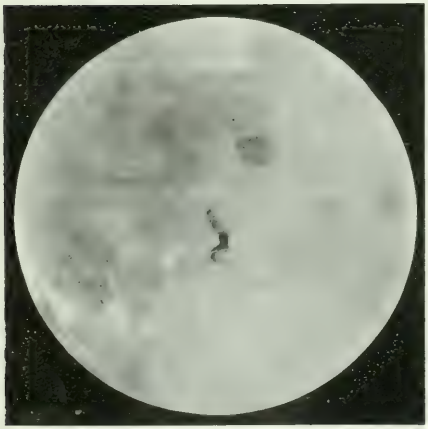


Fig. 3

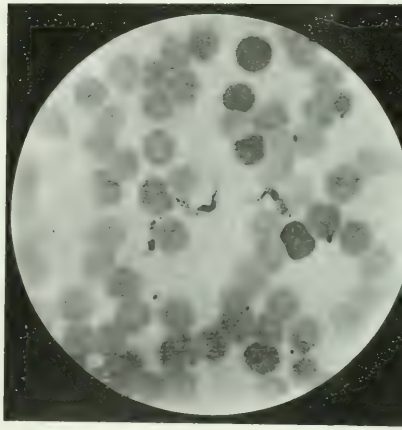


Fig. 4

PLATE IV

PHOTOMICROGRAPHS OF GAMBIAN HORSE TRYPANOSOMES

Fig. 1. Horse trypanosome. Small 'tadpole' forms in the blood of a mouse on the appearance of the parasite in the peripheral blood. × 840

Fig. 2. Horse trypanosome. From horse No. 1. × 840.
Note the two stumpy parasites in centre of photo.

Fig. 3. Horse trypanosome. From horse No. 1. × 840
Note longitudinal divisional forms in centre of photo.

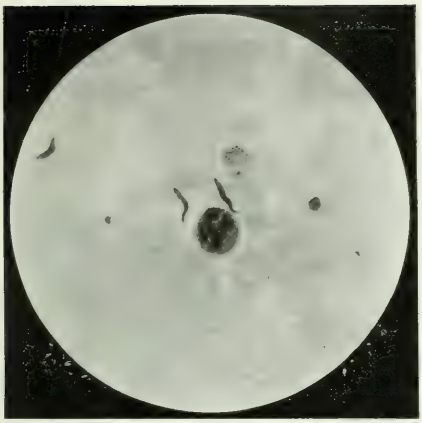


Fig. 1

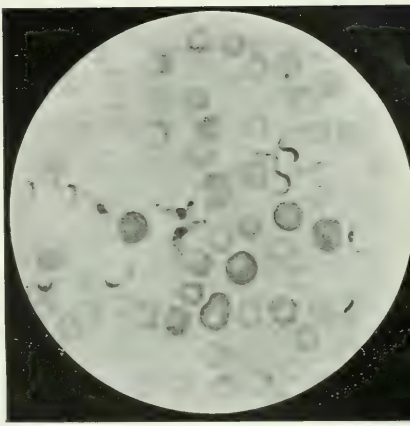


Fig. 2

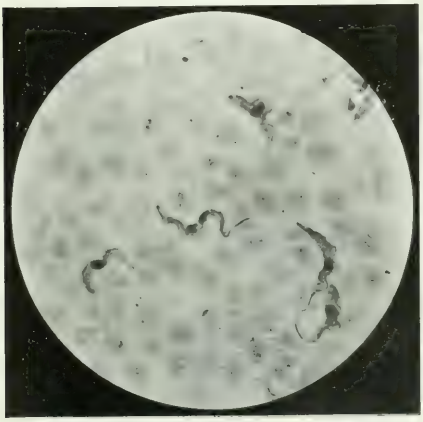


Fig. 3

Fig. 2

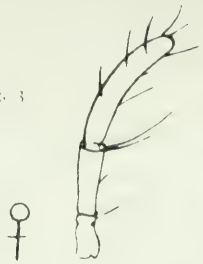


Fig. 3

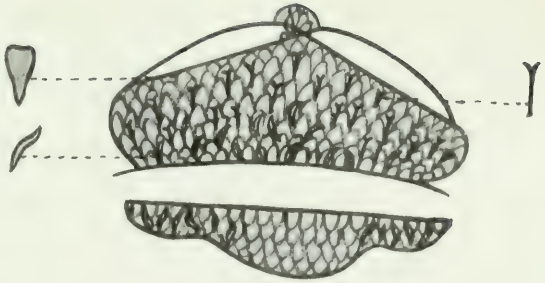


Fig. 1

Fig. 4

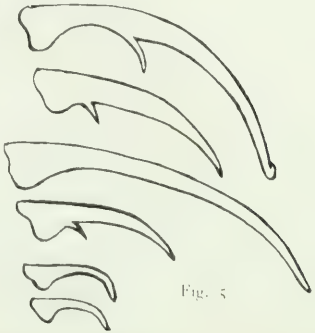


Fig. 5

Fig. 1. *Catagonyx senegalensis* (head ♂).
Fig. 2. Ungues ♀.
Fig. 3. Palpus ♀ × 60.
Fig. 4. Palpus ♂ × 80.
Fig. 5. Ungues ♂.

DISEASE.

Exp. CXXXIV

Notes of Case

Name: Chimpanzee "Jane"

Age

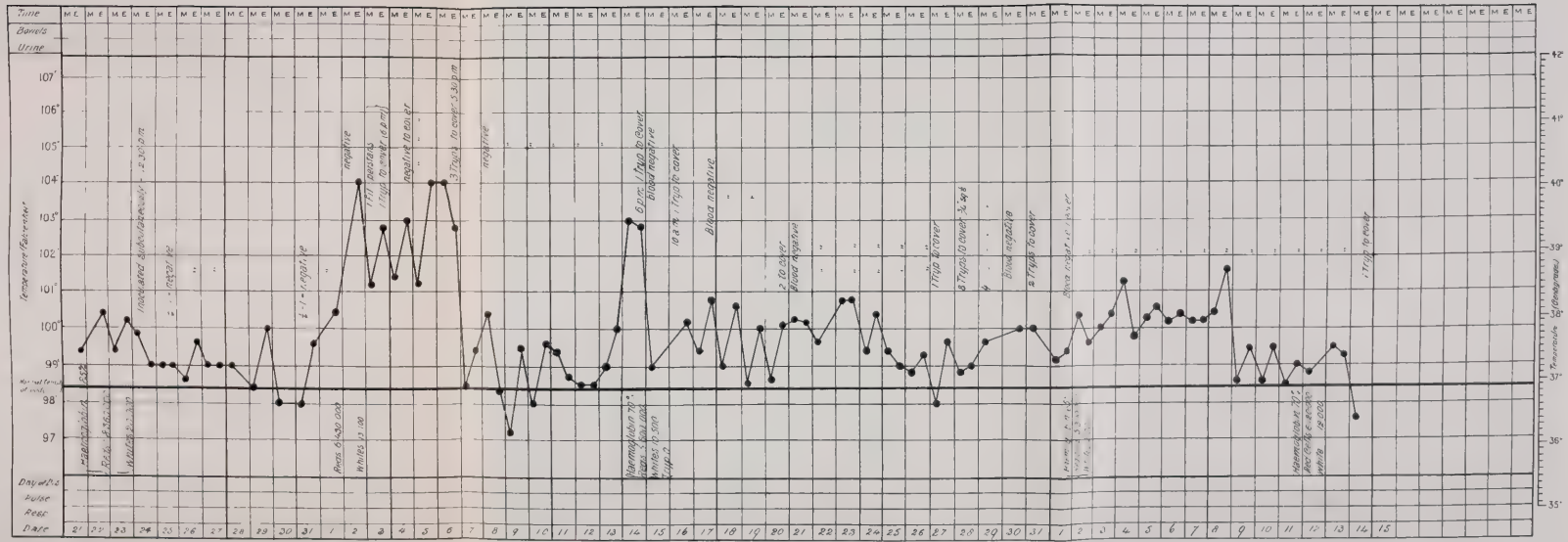
Diet

Case Book No.

Inoculated with 2.5 c.c. of blood from rats Exp. CXV & Exp. CXVI on July 26th subcutaneously. Nature not of blood inoculated in one never 1 Tryp to field

Date of Admission

Result



DISEASE.

DISEASE.

Notes on Case

Name { EXP LXXXVII / HORSE

Age

Diet

Case Book N°

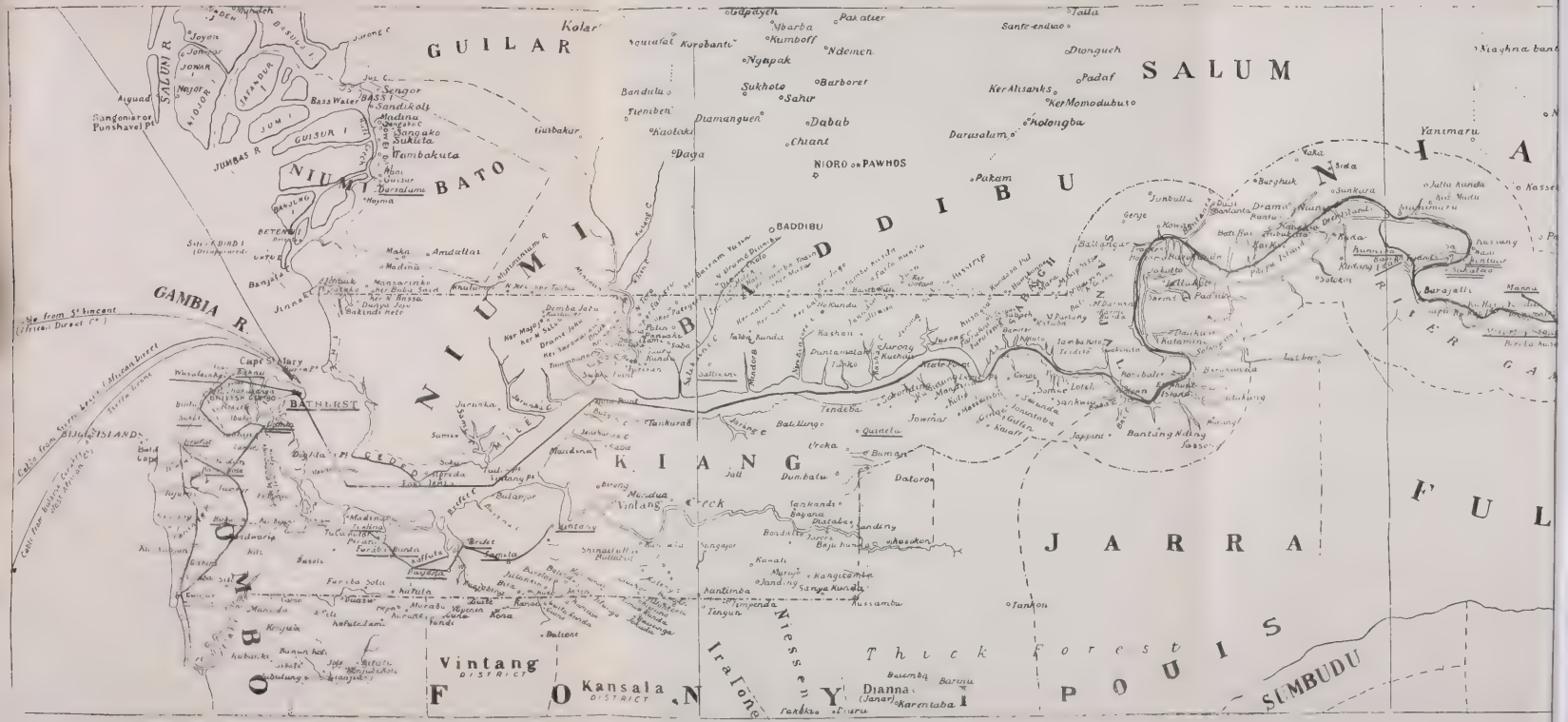
Inoculated hair in Cellular tissue of left ear with ½ cc blood from rat LXIX Feb 18th

On the 7th & 8th of Feb Blood Centrifuged + Negative

Date of Admission

Result

Time: ME ME ME


GUILAR
SALUM
NIUMI BATO
NIUMI BADDIBU
BADDIBU
GAMBIA R.
BATHURST
Cape St Mary
KIANG
JARRA
COMBO
Vintang DISTRICT
Kansala DISTRICT
Dianna (Janar)
Karentaba
Thick forests
SUMBUDU
POUIS
NIORO
PAWHOS
Kolar
Yantmaru
Niayhna
Sukhole
Barboret
Sahur
Dabab
Chiant
Daga
Durusalum
Padaf
Ker Momodubur
Holongba
Ker Alisanks
Ndemen
Nyapak
Kumboff
Ybarba
Pasalter
Sante-enduo
Diongueh
Tatta
Kapayeh
Korobanti
Diamanguen
Kaolaki
Fieniben
Bandulu
Gurbakur
Pakam
Burghuk
Junbulla
Genje
Drama Kantu
Kuntaur
Kaka
Sida
Sankuiya
Jalla Kunda
Kassang
Burajalli
Manna
Barra
Gambia
Jinnack
Banjala
Maka
Madina
Amdallai
Durayne Joy
Bakindi Nelle
Ker Bubu Saida
Ker Nanta
Ker Mansorinko
Ker Majola
Ker Wolli Sait
Ker Kundu
Ker Ibrahim Yoshe
Ker Abram Yoshe
Ker Bubu Jobe
Ker Ibrahim Bunja
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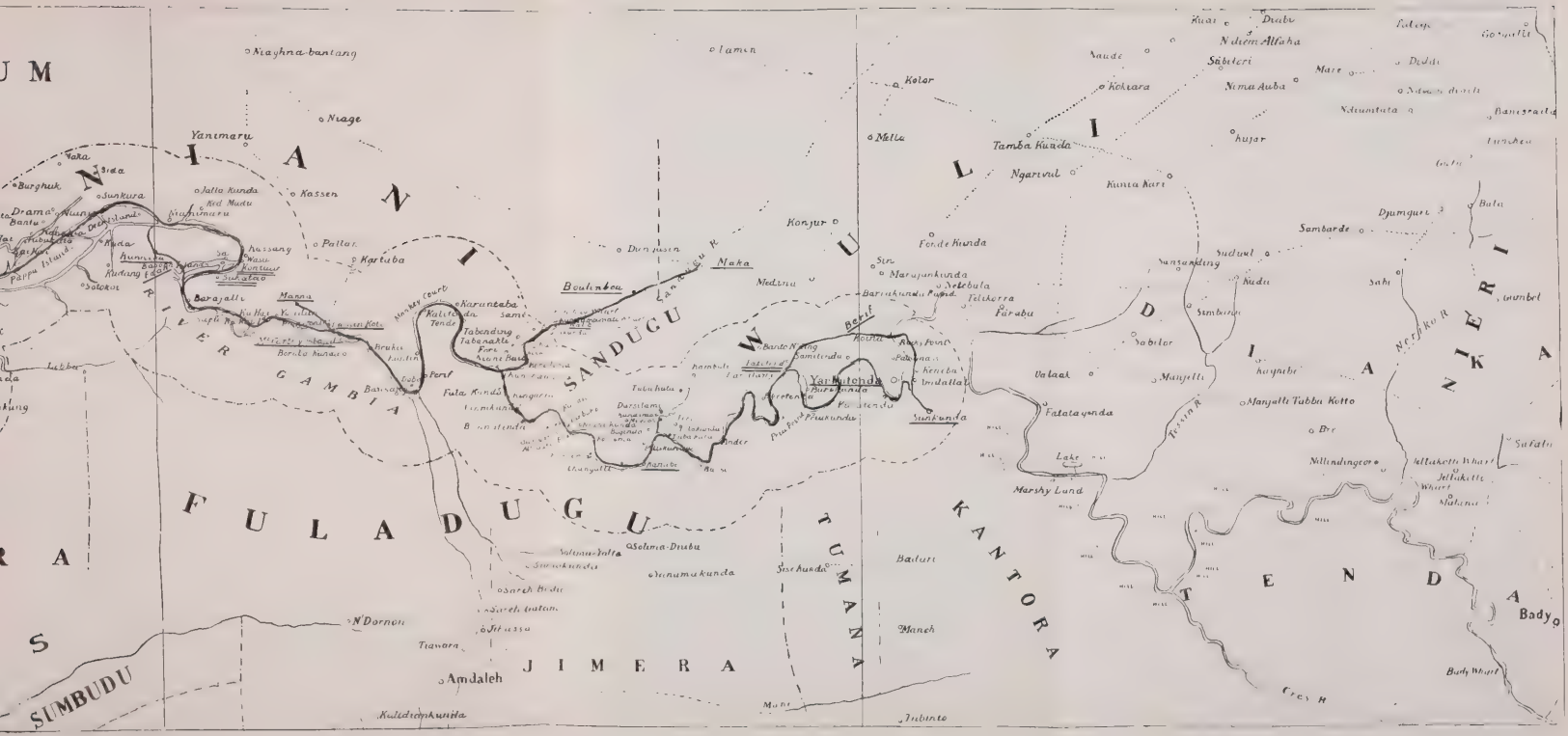
Niayhna-bantang
Lamin
Yanimaru
Niage
Kolor
Nakka
Burghuk
Sunkura
Jalla Kunda
Red Madu
Kassen
Pattar
Kartaba
Konjur
Maka
Nedrinu
Boulimbou
Barajally
Karuntaba
Tabending
Tabanaka
Fori
Kiang Baba
Perif
Futa Kunda
Sandugu
Yarbutenda
Sunkunda
Fatatayenda
Manjelli
Manjelli Tubbu Kotto
Valaal
Lake
Marshy Land
Nilliandingeo
Jellakotto Wharf
Jellakotto
Malanai
Sufafai
Bady
Bady Wharf
Grey R
Tendaba
Kantora
Tumana
Jimera
Fuladugu
Sumbudu
Gambia R.
Niokolo R.
Nderi
Kuar
Dudu
Ndiem Alfaha
Sabiteri
Nema Auba
Kokiara
Tamba Kunda
Ngarivul
Kunta Kart
Sambarde
Djumgure
Bala
Sudjul
Sabi
Sambang
Farabu
Sabitor
Kuyabi
Fonde Kunda
Marjankunda
Nebula
Felikerra
Barrakunda
Kenieba
Imdalla
Kunda
Tubakuta
Darsilami
Kuntaur
Bansang
Bondali
Bonko Kunda
Brikama
Kaur
Kuntaya
Kaiaf
Kerewan
Berending
Jattakunda
Saloum-Dalta
Selima-Dimba
Saloum R.
Sareh Bidir
Sareh Kotam
Jifarassa
N'Dorner
Tiawara
Amdaleh
Kuldrophunda
Mahi
Jubinto
Baiurt
Maneh
Sisé Kunda
Dranumakunda

THE ANTI-MALARIA MEASURES AT ISMAILIA

THE ANTI-MALARIA MEASURES AT ISMAILIA

BY

RUBERT BOYCE, M.B., F.R.S.

GEORGE HOLT PROFESSOR OF PATHOLOGY; BACTERIOLOGIST TO THE CITY OF LIVERPOOL
DEAN OF THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE

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THE ANTI-MALARIA MEASURES AT ISMAILIA

BY
RUBERT BOYCE, F.R.S.

EARLY in 1902, the Suez Canal Company, through their Chairman, Prince d'Arenberg, approached Sir Alfred Jones, Chairman of the Liverpool School of Tropical Medicine, to allow Professor Ross to proceed to Ismailia and advise upon a method to rid the town of mosquitoes, and to prevent the very serious annual sickness and mortality from Malarial Fever. The Committee of the School heartily gave permission for the necessary leave, and Professor Ross proceeded to Ismailia, where he arrived September 17, 1902, in company with Sir William MacGregor, who wished to investigate for his own information the malaria problem at Ismailia.

The *Anopheles* had already been discovered by Drs. Pressat and Dampeirou, the Medical Officers of the Company. Professor Ross confirmed their observations and proceeded to make a careful examination of all possible breeding-places and to suggest a plan of campaign. His recommendations have been carried out with great success. Mosquitoes are now rare, and the number of malaria cases have been reduced from two thousand two hundred and eighty-four, in 1900, to two hundred and nine, in 1903, in a population of nine thousand, and no deaths from malaria are recorded for the first time in 1903 amongst the Europeans. This anti-malarial experiment undertaken by a great business Company, minutely watched by numerous officials and with most carefully kept statistics, affords the most convincing proof of the feasibility and commercial advantages of well-directed anti-malarial sanitation that has yet been seen. To Egypt it adds another to its long list of successful enterprises, and it is an example to all our malaria-plagued towns in West Africa, India, and elsewhere. It will do more than any other experiment to remove the scepticism to vigorous action which has hindered the progress of this great sanitary reform as it has hindered other reforms. The Canal Company are to be congratulated upon a success only equalled by Havana, where a most vigorous anti-mosquito campaign has ended in banishing both yellow fever and malaria from what was until recently one of the most fever-stricken of cities.

Ismailia

On February 7, 1904, sixteen months after my colleague Ross's visit, I was invited by the courteous chairman of the Company, Prince D'Arenberg, to visit the town and see for myself the steps they had taken to form, what the Directorate hoped very shortly will become a sanatorium and a healthy inland sea-bathing resort for the Cairenes, out of what was until two years ago a mosquito-plagued town and a nest of malaria. Ismailia is a well-situated and pretty town of some nine thousand inhabitants, of which two thousand are Europeans, the remainder, Arabs ; the latter are contained in three villages, and are separate from the European quarter. The town is thirty years old, and owes its origin to the Suez Canal Company, who in the past as well as at present have spared no pains to make it a model one. Avenues of trees were planted, gardens were laid out, the streets were well made, good houses were constructed and surrounded by plenty of garden space, and marshy spots were early planted with quick-growing trees in order to drain them. The town reaches down to the salt-water lake Temsah, the channel of the canal being indicated by buoys. The large fresh-water canal from the Nile also passes through the town, and furnishes the water necessary for irrigation. The Company's hospital is very well situated on an eminence overlooking a very fine part of the canal and is well removed from marsh and dwellings. The carefully planted town and well-placed hospital did not, however, prevent malaria, and mosquitoes infested both the houses and the hospital. Indeed, it was found that mosquitoes were more abundant in the European quarter than in the irregular, dirtier, native quarters. This is now readily explained by the fact that there were far less breeding-places in the Arab quarter, where there were none of the garden drains, water-closets, and fountains abundant in the European town. Dutton, in his Report of the Malaria Expedition to the Gambia, in 1902, has called attention to a similar condition in Bathurst.

> He states that 'the number of mosquito breeding-places present in compounds was found to vary with the social position of the occupier. In small compounds of the poorer natives, where one or two huts were present, no breeding-places were found. These natives had no discarded bottles, etc., in which water could collect, nor were wells or tubs or any article for the storage of water present, sufficient water for the day being drawn from one of the public wells. These compounds were exceedingly clean and tidy, and no mosquitoes were found breeding in them. Excepting these, breeding-places were found and increased in extent and number in proportion to the wealth and position of the occupier of the compound, reaching a maximum on the premises of the larger traders (natives and white), where innumerable facilities for the development of mosquitoes were afforded. These breeding-places included all those domestic articles which are capable of containing a small quantity of water after showers lasting over a week without being dried up, or are not dried up between

the frequent showers in the wet season. Such articles found were broken bottles, either stuck on the wall or scattered over the compounds, iron pots, old calabashes, tin-lined packing cases, coacoanut husks, fowl troughs, and old tins of the factory compounds. The more specialized breeding-places included tubs, used for the storage of rain-water, or as wash-tubs for bottles, or in which water was placed for the preservation of the tub. Large barrels in which fibres were soaked, garden tubs in which water was stored for gardening purposes, old iron boilers for the collection of rain-water, improperly covered rain-tanks formed other breeding-places. In some of the factories a small gutter, six inches across by four feet deep, is let into the cemented floor of the yard around the ground-nut storehouse. This gutter is kept full of water to prevent the entrance of the ground-nut insect into the store. These gutters swarmed with mosquito larvae. In some yards a small channel runs down the centre to drain off rain-water, and is generally covered with a board. It was found that some of these had become clogged up at intervals with sand and rubbish, so that small pools of water collected along their course ; these pools acted as breeding-places for mosquitoes. An account of an examination of one of the larger European factories will illustrate to what extent mosquitoes are bred by the white man in the tropics on his own premises. In the factory yard were six barrels containing water for gardening purposes, and besides this number of tubs there were eight small wells, all uncovered. In all these articles mosquito larvae were present ; in the barrels in the yard the water swarmed with *Culex* and *Stegomyia* larvae, and in the wells and tubs in the gardens the larvae of *Anopheles* and *Culex* were found in all of them in good numbers. Besides these breeding-places there were many domestic articles scattered about in odd corners of the yard, which in the wet season would also have acted as breeding-places.'

Co-operation between the Residents and the Suez Canal Company

The Canal Company is the controlling force everywhere, and the success of this experiment no doubt is greatly due to their having themselves carried out the work and having been helped by the residents who are their employees. This co-operation between the inhabitants and the local authority is essential to efficient sanitation anywhere, and critics may be disposed to regard the success at Ismailia as difficult of realization in, say, a West African town. But in Havana, the American Sanitary Service had a most difficult task before them, and they won, and similarly, as this report shews, as well as the other numerous reports of anti-malarial work undertaken by the Liverpool Committee, the mosquito nuisance and, therefore, the danger to infection is due to a very large extent to the breeding facilities which exist in connexion with each house, and it is not too much to expect the European trader, if he wishes to ward off disease and consequent loss of time to, at least, set his own house

in order. With the native quarter the task is much more difficult, but first let the quarters of the more sensitive European be made healthier. In the past the Company had consulted various authorities upon the best means of diminishing the prevalent malaria, and, as a result, some land has been drained and planted. Curious theories had also been put forward connecting the fever with the sub-soil water and the new sea canal, and costly systems of drainage were recommended. The officials on the spot long suspected that the small stagnant collections of water were responsible, but they could not furnish the scientific explanation. When, however, the connexion through the mosquito was demonstrated by Ross, they saw at once its probability, and they determined forthwith to put his extirpation method to a practical test.

Breeding-places of Mosquitoes

The breeding-places of the mosquitoes in general were found to be the small channels leading from the sweet water canal, and which served to irrigate the agricultural land and gardens ; patches of low-lying marshy land, fountains in the private gardens, drains, water closets, receptacles, cess pits, and especially the pits or wells which are sunk in the ground close to the house, and into which bath or slop waste is carried. These wells or *puits perdus* are not deep, they are ventilated, and from them the water soaks gradually into the surrounding soil, but constant recharging with waste water maintains sufficient water for breeding purposes ; access to the pit is readily obtained by the mosquito through the ventilator or through the drain pipe to the bath or kitchen scullery. In addition to these sources, all stagnant collections of water, such as might be found in stable drains, washing troughs, and cisterns, furnished conditions favourable to breeding. As long as the water was flowing unimpeded in the stream the mosquito did not choose it as a place suitable for depositing her eggs, but if obstruction took place, caused either by the growth of weeds or the banks falling in, larvae soon began to shew themselves.

Monsieur Tillier also observed that larvae did not appear in the large deep metal cistern from which the town was supplied with drinking water, and he attributes this to the depth of the water.

The *Anopheles* discovered by Dr. Pressat and Dampeirou were found in houses in the town, and their breeding-places were found to be almost entirely limited to shallow stagnant pools in the small areas of marshland.

Following Ross's directions, two anti-mosquito brigades were formed, one, the 'Drains Brigade,' composed of five natives and one European in charge, whose duty it was to keep all drains clear. The other, the 'Petroleum Brigade,' consisted of four natives in charge of a European, was told off to add petroleum to all collections of water which could not be removed at once. In addition to forming these brigades, the company undertook extensive drain-clearing operations and the filling in of a considerable area of waste marshland with sand.

In company with Prince D'Arenberg, Sir John Hardy, Mr. William Johnston of Liverpool, M. Duellenec, the Consulting Engineer, M. Doyen, the Estate Manager, and under the special guidance of M. Tillier, chief of the Transport Service and a keen zoologist, I made a tour of inspection. We first visited some agricultural land plentifully supplied with the irrigating channels characteristic of Egypt. The water in these is supplied from the sweet water canal, and, as it stands at a higher level, there is considerable fall, circulation can be maintained, and a good head of water can be readily obtained for flushing purposes. Once a week the 'Drain Brigade' pays it a visit, cleanses the drains by sending down an extra flood of water and removes any weeds or accumulations of sand. Constant supervision is necessary to keep the irrigating and drainage channels free from obstruction, as the banks are of sand, and weeds grow rapidly. The least stagnation affords a nidus for the mosquito. The large sweet water canal does not appear to harbour larvae, the fish to a great extent preventing this. I particularly enquired whether larvae were ever observed in the sea-water canal. I did so because I was surprised to find fresh water grasses and other fresh water plants growing along the margin of the canal, and even in the water of the canal itself, which is strongly salt. The explanation given to me of this occurrence was that the subsoil fresh water in the bank of the canal afforded the necessary moisture for the roots, the stems of plants which had their roots in fresh water growing through a considerable depth of salt water. The riparian growth of vegetation is naturally encouraged by the Canal Company, as it is a valuable aid in binding together the otherwise shifting sand of the sides of the canal. No larvae have hitherto been observed amongst the plant growth, but the possibility of such an occurrence should not be lost sight of in view of the very interesting observations recorded by Ross and Dr. Dutton upon the breeding of mosquitoes in brackish and salt waters. We next drove to an opposite part of the town, where the authorities had nearly completed the filling in with sand of a considerable strip of low-lying marshy land. This will in future ensure the prevention of the formation of any pockets of stagnant water.

We next proceeded to the examination of the system of mosquito prevention adopted in the town itself, M. Tillier taking his own house and garden as a typical example of the others in the European quarter. Once a week the 'Petroleum Brigade' visits the house and pours a mixture consisting of equal parts crude and ordinary petroleum into all collections of drains and waste water which do not soak away during the course of the day. Petroleum is poured into the water closets and into the *puits perdus* mentioned above which receive the bathroom and kitchen waste. The garden fountain is emptied, and if any water still remain in it which cannot be removed, petroleum is added; it is refilled after twelve hours. Similarly, the stable drains, washing troughs and all receptacles containing waste water are flushed or emptied or petroleum added. The essence of the procedure being to either empty and cleanse and then renew all water receptacles, or to add petroleum when this cannot

be done. But nothing must be overlooked, as it has now been abundantly proved that the mosquito breeds in most unexpected places, and intelligent direction is therefore absolutely necessary ; for this reason, the Company have found that it is essential that the brigades have at their head Europeans. The work must not be left to the native alone. Naturally here more especially the co-operation of the householder is all important ; time after time it has been pointed out in the Malarial Reports of the Liverpool Committee that the cause of mosquitoes in the residential house or in the hospital is due to the drinking-water cistern or to some equally simple and preventable source. This, too, may be the case in places where little effort is made by the European, because of the apparent hopelessness of being able to drain some large marsh somewhere in his locality. The power of prevention which lies in the hands of every householder in a mosquito-plagued town cannot be emphasized sufficiently, and it is very gratifying to learn that at Cairo, Lord Cromer and the residents around him have commenced amongst themselves a local anti-mosquito campaign. The willingness of the private individual to assist in the work is a guarantee to the public authority—whether a company or a government—of the earnestness of the movement, and encourages them to undertake their share of the larger work of directing and co-ordinating operations, draining, etc. During our numerous drives through the town we encountered only one example of *Culex*, the species of which we could not identify, and during the night I slept without mosquito curtains. In M. Tillier's words there are no more mosquitoes in Ismailia than are to be met with in Paris. On the other hand, at Port Said, and at the other stations in the vicinity, there is an abundance of mosquito-life, and every traveller to Egypt in the winter soon realizes this fact. The railway compartment in which we were travelling from Suez contained very large numbers, and I caught many of them.

It is a great deal accomplished when the unpleasantness caused by the bites of mosquitoes is abolished, but this is only after all a small thing compared with the immense practical gain if the abolition of the mosquito brings with it the prevention of a disease like malaria. This is what Ross has shown does occur, and the Ismailian experiment is a great practical proof of it, as the following tables demonstrate.

The Malarial Statistics of Ismailia.—It is a very great advantage that the Company have their own Medical Officer, Dr. Pressat, in charge of the hospital and the laboratory. The accurate diagnosis of malaria can be made, and therefore the statistics become of special value in an experiment where it is essential to make sure that the parasites are present in the blood of the affected persons ; the recent statistics have been drawn up with a view of arriving at the accurate number of real cases of malaria. I am indebted to Prince d'Arenberg for having obtained for me the following tables, which have been prepared by Dr. Flood, the District Sanitary Inspector :—

Table I

Statisque du paludisme à Ismailia

Mois	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
Janvier	83	94	201	156	128	162	13							
Fevrier	103	83	165	139	83	105	20							
Mars	129	126	129	266	99	101	16							
Avril	135	127	109	175	100	64	14							
Mai	173	77	126	169	82	133	9							
Juin	180	43	126	114	68	154	15							
Juillet	188	81	104	145	74	120	23							
Août.....	242	86	107	166	123	130	19							
Septembre	336	128	128	258	244	176	25							
Octobre	254	178	172	228	372	150	39							
Novembre	178	271	209	244	352	174	12							
Décembre	88	251	208	182	265	73	4							
	2,089	1,545	1,784	2,284	1,990	1,551	209							

Table II

Mortalité parmi la population d'Ismailia
(Ville Européene et les 3 Villages Indigènes pendant les trois dernières années)
1901-1902-1903

Années	Mortalité Générale			Mortalité par Maladies infectieuses																		Mortalité par Malaria						Observations
				Choléra			Fièvre typhoïde			Diphtérie			Variole			Rougeole			Cachexie paludéenne			Fièvre pernicieuse			
	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	Européens	Indigènes	Totaux	
1901	38	136	174	...	...	...	...			...	1	1	...	...	..	...	...	..	2	14	16	2	...	2	(1) Tous laissés sans soins.
1902	54	241	295	5	15	20	...	2	2	...	5	5	.	...	...	...	3	3	2	29	31	4	5	9	(2) Pendant les 3 premier mois de l'année, 1903.
1903	32	138	170	...	..	...	1	...	1	...	1	1	...	...	...	...	...	...	...	4	4	...	...	...	

Population d'Ismailia (Ville Européene et les 3 villages (1e village, 2e village, El Arachieh ou 3e village) :—

Européens — Entre 1900 et 2,000 } Total, 9,000 environ.
Indigènes — Environ 7,000 }

Ismailia, *le* 17 *Janvier*, 1904.

(*Signé*) Dr. T. M. Flood
Inspecteur Sanitaire.

In Table I it is seen that there is a great drop in the number of malaria cases in 1903—from two thousand two hundred and eighty-four in the nine thousand inhabitants to two hundred and nine in the same number of inhabitants in 1903. In Table II the mortality from all causes is given. There is a definite decrease in 1903 of deaths from malaria ; there are in fact no deaths in the European population, and only four amongst the natives. In 1902 there were a total of six deaths amongst the Europeans and thirty-four amongst the natives. In 1901 there were four deaths recorded in the European population and fourteen in the native.

The tables furnish evidence that during the short time in which anti-malarial work has been practised a very substantial improvement has been obtained. A fall from one thousand five hundred and fifty-five cases, in 1902, to two hundred and nine, in 1903, is a very large one, and if with this we have the fact that the number of mosquitoes were reduced to vanishing point, in 1903, there can be little doubt that the campaign has practically brought about the total prevention of malarial infection in Ismailia.

From the above short account of the anti-malarial methods employed, it is, I think, very clear that in them we have but an extension of sound sanitation. The cleansing of drains, the flushing, the regular washing out of night-soil reservoirs, the frequent and regular renewal of water, the filling in of low marsh land and the addition of petroleum to stagnant water, are methods of cleanliness which have a very direct beneficial effect upon the health of a community. With the destruction of the gnat disappears not only malaria or yellow fever, if it is present, but also the possibility of infection in the case of bacterial diseases, such as plague, which may be transmitted from an infected to a sound individual by the probosis of the gnat.

Expenditure

The cost of the Anti-Malarial operations. —In filling in marsh land and cleaning out drains, the Directorate have spent £4,400. The 'Drain Brigade' costs £200 a year and the 'Petroleum Brigade,' £520. Neither the expenditure of £4,400 in the initial cleansing operations, nor the annual expenditure of £720 in maintaining a satisfactory condition can be regarded as large. The return is very great, there is a great diminution of the sickness rate, there are fewer cases in the Company's hospital and fewer of the Company's servants are incapacitated from work. The life of the Company's servants is rendered much safer, and the town is made attractive as a health resort.[1]

1. The pretty gardens and plantations and the view of the blue lake lend the town the appearance of an oasis with both European and Arabian cultivation. The air is healthy and not moist in spite of the proximity of the water. —Baedeker, *Egypt*, 1902.

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REPORTS OF THE TRYPANOSOMIASIS EXPEDITION TO THE CONGO

1903-1904

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1903-1904

OF THE

LIVERPOOL SCHOOL OF TROPICAL MEDICINE
AND MEDICAL PARASITOLOGY

BY

J. EVERETT DUTTON, M.B., VICT.

JOHN L. TODD, M.D., McGILL

AND

CUTHBERT CHRISTY, M.B. EDIN.

WITH A COMPARISON OF THE TRYPANOSOMES OF UGANDA
AND THE CONGO FREE STATE

BY

H. WOLFERSTAN THOMAS, M.D., McGILL

AND

STANLEY F. LINTON, B.Sc., M.B., LIVERPOOL

AND A NOTE ON TSETSE-FLIES

BY

E. E. AUSTEN

ZOOLOGICAL DEPARTMENT, BRITISH MUSEUM

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PREFACE

IN 1901 trypanosomes were discovered in the blood of a European by Dr. J. E. Dutton, Walter Myers Fellow, while on an Expedition of the Liverpool School of Tropical Medicine to Gambia. In consequence of this observation an Expedition composed of Drs. Dutton and Todd was sent in 1902 by the School to Senegambia to prosecute further researches in trypanosomiasis. The detailed report of the Expedition was published in 1903, and contained a study of the pathogenic trypanosomata of man and animals, several new species being described.

Prior to the return of this Expedition, the discovery of trypanosomes in the cerebro-spinal fluid of cases of Sleeping Sickness in Uganda by members of the Sleeping Sickness Commission of the Royal Society caused the subject of trypanosomiasis to assume great importance. At the same time it was brought to the notice of the Committee of the Liverpool School that in the Congo Free State the native population had from time to time suffered from very fatal epidemics of this disease. The Committee therefore decided to accept the invitation of His Majesty King Leopold to send an Expedition to study Sleeping Sickness in that country. Drs. Dutton and Todd were recalled from the Senegambia, and as soon as they had drawn up their reports they left for the Congo in September, 1903, and were soon after joined by Dr. Christy, who had served previously on the Royal Society's Sleeping Sickness Commission in Uganda. On reaching the Congo the Expedition decided to make Leopoldville its headquarters. The authorities of the Free State at the same time attached Dr. Inge Heiberg, an old pupil of the School, to the Expedition, and to him the members are greatly indebted for his aid in the work. A special hospital was erected by the State, in order that the observers might have the Sleeping Sickness cases under their care, and facilities were given for the study of a large number of patients. The results of these investigators are incorporated in the present volume, and illustrate the occurrence and distribution; describe the symptoms of trypanosomiasis in all its stages, both in Europeans and natives, and shew how Sleeping Sickness, so-called, is related to trypanosomiasis as a symptom of that disease.

At the same time the Committee resolved to continue the researches on trypanosomiasis in Liverpool, which had been started by Drs. Dutton and Todd in Senegambia ; Dr. Thomas was appointed to conduct the work, and aided by Dr. Linton experiments were immediately commenced, a preliminary note of their work being embodied in this report. The two groups of observers have throughout worked together, and in order that comparable data might be obtained, selected cases of Sleeping Sickness were, by permission of the Congo Free State authorities, sent to the observers in Liverpool. A later report will be published on these cases. As far as the very numerous and detailed observations of these workers go, they shew that the parasite identified with Sleeping Sickness in Uganda and the Congo does not differ from that described by Dutton in the Gambia. This view is also held by Laveran and Mesnil in France, and Bruce in this country. The question of a curative agent has for a considerable time engaged the attention of the members of the research, and experiments are now in progress to find a remedial agent which would have the same effect in trypanosomiasis that quinine has in malaria. A variety of drugs have been used with more or less success ; up-to-date, arsenic and trypan red, an aniline dye introduced by Ehrlich and Shiga, appear to be the most useful ; the parasite disappears for a time from the blood, and the life of the animal is prolonged, but with neither of the drugs is an absolute cure attained. A combination of the two appears to offer better results ; a large number of animals infected with different trypanosomes are under treatment. The present report also embodies an important note on the Tsetse-flies, by Mr. E. E. Austen, to whom the School is much indebted for describing and identifying the Diptera obtained during the Expedition.

Much important work remains to be done ; a further study of the disease from a clinical aspect, extended experiments on the transmission of trypanosomic diseases by biting flies, and researches on the lines of Schaudinn's work, together with therapeutical observations in patients and large animals naturally infected with trypanosomes, are urgently needed.

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HUMAN TRYPANOSOMIASIS ON THE CONGO

HUMAN TRYPANOSOMIASIS ON THE CONGO

(Being the First Progress Report of the Expedition of the Liverpool School of Tropical Medicine to the Congo, 1903) *

BY

J. EVERETT DUTTON, M.B., Vict.

WALTER MYERS FELLOW, UNIVERSITY OF LIVERPOOL

J. L. TODD, B.A., M.D., C.M., McGill

AND

CUTHBERT CHRISTY, M.B., Edin.

AT the request of His Majesty King Leopold II, King of the Belgians, this expedition was sent in September last to the Congo Free State to report upon the sanitation of the larger towns, and to continue the School's work on human trypanosomiasis. Through the kindness of the Governor-General of the Congo, and of Drs. Vourloud and Neilseng, government physicians at Boma, the hospital for natives at Boma was opened to us. It contained about sixty-five patients, and we saw there eighteen patients who had been admitted as cases of sleeping sickness.

Whether admitted to hospital by the medical officers, or pointed out to us by the missionaries as cases of sleeping sickness, with three or four exceptions, the cases which we have as yet seen have been, in our opinion, very unlike what has hitherto been described as sleeping sickness. Continued sleep or even abnormal sleep has been almost absent from many of the cases. It has been absent even in those who were believed to be in an advanced stage of the disease and who ultimately died. In only three or four of the cases observed by us has somnolence been a marked feature, and only in these few cases have the symptoms in any way coincided with those observed by one of us during the Uganda epidemic of sleeping sickness.[1]

From November 4 to November 29 two of us were occupied in travelling through the cataract region, in order to ascertain for ourselves the exact conditions existing there. Reports sent to the Congo Free State officials, and handed on to us, as well as correspondence received by ourselves, led us to believe that in this district we should find, not only an epidemic of sleeping sickness, but that the whole population was being 'decimated' by the disease. Although, in the course of our

* Reprinted, by permission of the publishers, from the British Medical Journal, 1902, 2, 1924.

journey, we visited many villages and made tiresome expeditions to visit those especially mentioned to us, not a single case of illness did we see in which sleep was a marked feature.

We stayed for some time at the Baptist Missionary Society's station at Wathen, in the Lutete district, where we received hospitality and assistance at the hands of those in charge of the mission. From here excursions were made into the surrounding district, and a large number of persons brought to us as cases of sleeping sickness were examined.

These consisted of a heterogeneous collection of men, women, and children, many of whom were found to be suffering from heart, lung, and other more or less common ailments. Amongst the boys it seemed that a diagnosis of 'worms' was sufficient in many cases to account for the symptoms. Cases of apparent starvation and neglect were also common, and it appeared from what we were told that, owing to there being a general belief in the contagiousness of 'manimba'—the native name for what is believed to be sleeping sickness—children and even adults were, as soon as the slightest symptoms developed, liable to be isolated and shunned by everyone, causing, eventually, a state of emaciation and filth which ended sooner or later in death. Apart from these, however, and eliminating the many common ailments, there still remains in the cataract region a class of cases which, undoubtedly, terminate fatally within a year or two. These cases, of which most villages visited by us contained one to three examples, have few very evident symptoms of illness beyond emaciation, and, in some cases, weakness, headache, enlargement of lymphatic glands, and dirty, dry, scurvy skin. In a proportion of these cases trypanosomes were found in the peripheral blood, and we think it probable that if a systematic examination were possible, the parasites would be found in a much larger number.

Trypanosomes have been found in the finger blood both of those cases in which the diagnosis of sleeping sickness was certain, and of those in which the case picture was atypical. In addition, trypanosomes have been frequently seen in the peripheral blood of apparently healthy individuals. The routine method adopted for the detection of the parasites in the peripheral blood of unsuspected cases was the simple examination of a rather thick, freshly-made, cover-slip preparation. All of the following persons were examined in this way :—

Place and Class of Natives	Number Examined	Number Infected with Trypanosomes in Peripheral Blood	Number of Cases Admitted to Hospital or shown to us as Cases of Sleeping Sickness	
			With Trypanosomes	Without Trypanosomes
BOMA				
1. Hospital at Boma. Native soldiers coming from all parts of the Congo	72	11	9*	–
2. Prisoners in Boma gaol coming from all parts of the Congo	181	1	1	0
3. Children of native soldiers at Boma	19	0	0	0
4. Colony school. Native boys from all parts of the Congo	50	1	0	0
5. Native labourers and children from native quarter	34	0	0	0
MATADI				
1. Natives collected for examination by Dr. Sims	78	1	1	0
2. Children of native soldiers up to 8 years of age	10	0	0	0
3. Patients at the native hospital	22	3	2	2
4. Children at the Sansel, native quarters, up to 10 years of age	28	0	0	0
CATARACT REGION				
1. Carriers collected from Tumbar District	20	2	0	0
2. Carriers from Lutete District	23	0	0	0
3. Boys at Wathen Mission, ages up to 15	35	1	0†	0
4. Natives examined indiscriminately at two small villages near Lutete	42	2	0	2
5. Natives coming to the mission for treatment, or sick natives seen in village within a twenty mile radius of Lutete	79	11	10	47
6. Cases collected for us as sleeping sickness cases by Chef de Post at Kusu from neighbouring villages	14	0	0	14

* Lumbar puncture was done in six of the sleeping sickness cases. In four trypanosomes were seen in the cerebro-spinal fluid. One of the four never showed trypanosomes in the peripheral blood.

† This boy had been suffering for twenty-four days previous to our arrival at the mission from a fever which was not amenable to quinine.

Case VI

Sleeping Sickness (September 30, 1903).—N'Bela, male, aged 24, agricultural labourer. A Mongo man. Patient never saw sleeping sickness before coming to Boma. Had lived in Boma for nearly three years. Illness commenced in July of this year. Admitted to hospital, August 1, 1903.

When the patient was seen (September 30) somnolence was already a marked feature of his condition. This symptom steadily became more marked as emaciation increased. When we left Boma (October 27) the patient was comatose, and death had been expected at any time during the preceding week.

General Condition.—Patient is thin and very weak. Questions are answered rationally, but only after a long interval. He displays a somnolent indifference to everything about him, and only by constant shaking can drowsiness be dispelled for a period long enough to permit him to speak.

Physical Examination.—Nervous system; co-ordination imperfect. Sense of weight good. Knee-jerks and superficial reflexes were obtainable, and showed no abnormality. Eyes reacted to light and to accommodation. Thoracic and abdominal examination showed nothing worthy of note. Lymphatic glands were all enlarged, hard, and freely movable. There was no haemorrhage into mucous membranes. Slight icterus of the conjunctiva was seen.

The accompanying chart indicates the course of the temperature in this case, and shows the results of the examinations for parasites. Trypanosomes were seen in both cerebro-spinal fluid and peripheral blood.

On October 9, 35 c.cm. of slightly clouded, colourless cerebro-spinal fluid were taken by lumbar puncture. No red cells were seen in the fairly profuse deposit formed by centrifuging. This precipitate contained a fair number of trypanosomes, many monuclear cells of large size, and numerous polymorphonuclear leucocytes.

Experimental Inoculation

The following animals have been inoculated from this case. The material inoculated was in each case demonstrated to contain living trypanosomes.

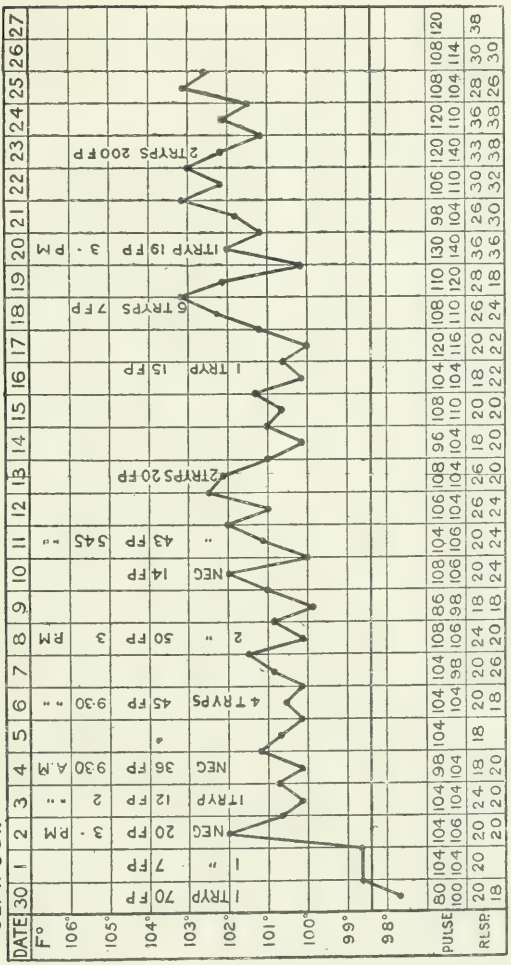
Animals Inoculated from Case 6

October 7. White mouse (Experiment 16) inoculated subcutaneously with 1 c.cm. cerebro-spinal fluid; infected October 25.

October 7. White mouse (Experiment 17) inoculated subcutaneously with 1 c.cm. cerebro-spinal fluid; never infected.

September 30. White rat (Experiment 5) inoculated subcutaneously with 5 c.cm. blood; never infected.

September 30. White rat (Experiment 6) inoculated intraperitoneally with 1 c.cm. blood; never infected.



TEMPERATURE CHART, CASE VI

Typ. = Trypanosome. F. P. = Filaria perstans.

October 4. White rat (Experiment 21) inoculated intraperitoneally with 4 c.cm. blood; never infected.

October 9. White rat (Experiment 22) inoculated subcutaneously with 8 c.cm. blood; infected October 23.

October 9. White rat (Experiment 23) inoculated intraperitoneally with 5 c.cm. blood; infected October 23.

Case IV

Simple Trypanosomiasis ('*Maladie de Dutton*')[2], September 22.—J. P., male, aged twenty-eight, native of Sierra Leone, where sleeping sickness is not endemic. Came to Boma six years ago as a Free State soldier. Has always been in lower river districts. Entered hospital September 22 with gunshot wound. Had gonorrhoea in 1902, otherwise has not been ill during his stay in the Congo.

Patient is a strong, healthy man, well nourished, skin moist and clean; slight oedema over both shins; patient does not complain of feeling ill.

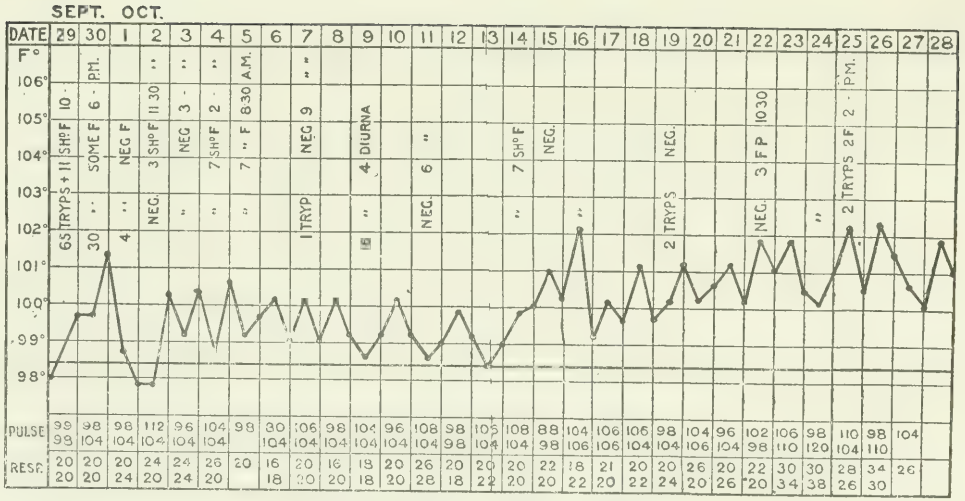
Glands are easily palpable, but are not markedly enlarged or hard. He is a bright, intelligent man, slightly deaf, but answers questions quickly and well. He is alert and interested in his surroundings. Mucous membranes are anaemic. There is a complete cataract of right eye. Heart and lungs are normal. Liver normal in size, but slightly tender. Spleen normal. Appetite good. Bowels constipated. Nervous system is normal.

Urine passed in twenty-four hours, 760 c.cm.; specific gravity, 1,002, light straw colour, cloudy precipitate, acid; small amount of albumen present, no sugar; urea, 0·41 gram to 100 c.cm. of urine. Microscopically a few pus cells, probably due to a chronic gonorrhoea, were seen.

On October 26, 10 c.cm. of limpid cerebro-spinal fluid, as clear as distilled water, were withdrawn with some difficulty by lumbar puncture. The patient almost fainted before 8 c.cm. had been withdrawn. A very slight percipitate was obtained after long centrifuging. On examination it was found to contain a very few red cells, and still fewer small mononuclear white cells. No trypanosomes were seen during a long and careful search of the whole of the precipitate.

The cerebro-spinal fluid from this case presented a very different appearance, both macroscopically and microscopically, from that obtained from sleeping sickness cases. The fluid was clear, not clouded. None of the large mononuclear or smaller mononuclear and polymorphonuclear leucocytes seen in sleeping sickness cases were present.

The accompanying chart shows the course of the temperature in this case, and indicates the occasions on which trypanosomes were seen in the peripheral blood.



TEMPERATURE CHART, CASE IV

Tryp. = Trypanosome. F. P. = Filaria perstans. Sh.F. = Sheathed filaria.

Experimental Inoculations

The following animals were inoculated from this case :—

Animals Inoculated from Case 4

September 30. White rat (Experiment 5) inoculated subcutaneously with 5 c.cm. blood ; never infected.

September 30. White rat (Experiment 4) inoculated subcutaneously with 1 c.cm. blood ; infected October 8.

October 27. Guinea-pig (Experiment 27) inoculated subcutaneously with 4 c.cm. blood, infected November 7.

October 27. Guinea-pig (Experiment 28) inoculated subcutaneously with 5 c.cm. blood ; infected November 18.

October 27. Rabbit (Experiment 24) inoculated subcutaneously with 6 c.cm. blood ; never infected.

Necropsies were done at Boma on four cases which were admitted to the hospital for sleeping sickness. Two of these died before their blood or cerebro-spinal fluid could be examined. Repeated examinations of the blood (centrifuge used) of the third failed to demonstrate trypanosomes. Lumbar puncture was not done on this case. In spite of repeated and very careful examinations of the blood and cerebro-spinal fluid of the fourth case, trypanosomes were never seen.

A necropsy was also done on the body of a native admitted to the hospital as a case of encephalitis. This patient never showed the usual signs of sleeping sickness, and finally died of dysentry. Many trypanosomes were seen in his finger blood. Lumbar puncture was not done.

The *post-mortem* appearances in each of these cases were very similar to those described as occurring in sleeping sickness.[3] The usual increase of subarachnoid fluid, which had become cloudy, or occasionally almost purulent, was observed. The superficial and substantial vessels of the brain and spinal cord were turgid, and in two cases small sub-ependymal haemorrhages were noted.

In addition to these changes in each case, lymphatic glands were enlarged, several were congested or injected, not infrequently members of the various groups of glands were to the eye either partially or—especially the smallest glands—totally haemorrhagic. The naked-eye appearances of these glands were particularly interesting to us since we have observed very similar changes in animals infected by us with *Trypanosoma gambiense*.

Experimental Inoculations

The following experimental inoculations were made in white rats, white mice, rabbits, and guinea-pigs, with the results indicated :—

Twenty white rats were inoculated with cerebro-spinal fluid or blood taken

either during life or *post-mortem* from patients admitted to hospital as cases of sleeping sickness and from cases of trypanosomiasis. Living trypanosomes in eleven instances were seen in the material inoculated. In seven of these the material inoculated was from cases of 'sleeping sickness,' in four from cases of simple trypanosomiasis. Of the former, three became infected; of the latter, two. None of the rats inoculated with material taken *post-mortem*, in which no living trypanosomes were seen, have ever become infected.

Four white mice were inoculated with cerebro-spinal fluid taken from two cases of sleeping sickness. Trypanosomes had been found in both cerebro-spinal fluid and blood of the first case, in the second trypanosomes were never seen. Two mice were inoculated with fluid containing many trypanosomes from the first case. One has become infected. Neither of the mice inoculated from the second case has ever shown parasites.

Two rabbits were inoculated with blood containing trypanosomes. The blood for one experiment came from a case of sleeping sickness, for the other from a case of simple trypanosomiasis. Neither animal has become infected. Four guinea-pigs were inoculated with blood containing trypanosomes, two from a case of sleeping sickness, and two from a case of trypanosomiasis. Both of the latter have become infected.

The very slight susceptibility of laboratory animals to infection with the trypanosomes found in man in the Congo, the great chronicity of the infection produced when inoculation has been successful, and the periodicity with which the parasite has appeared in the peripheral blood of the experimental animals, are points which greatly resemble the animal reactions of *Trypanosoma gambiense*.[6] The number of experiments done is not yet sufficiently large to permit the mention of incubation periods. During the eight or nine weeks which the infected animals have been under observation none of them have ever shown any gross sign of disease.

Conclusions

The examination of trypanosomes seen in stained specimens of blood from cases of trypanosomiasis, from cases of sleeping sickness (typical or doubtful), in the specimens of cerebro-spinal fluid of the latter cases, and in the blood of experimental animals, infected with either of three above-mentioned fluids, has led us to the following conclusions:—

1. The trypanosomes seen in the blood of man, whether symptoms of sleeping sickness were present or not, have always been the same. The number of cases in which trypanosomes from the spinal fluid have been examined is at present too small to permit of a definite description of morphologic characteristics. We have seen forms in the cerebro-spinal fluid similiar to those described by Bruce[3] and Castellani,[4, 5] and also longer forms similar to those seen in the finger blood of the same cases.

2. None of the human trypanosomes seen, whatever their source, have presented any morphologic appearance incompatible with *Trypanosoma gambiense*.

3. The parasites seen in rats inoculated with the cerebro-spinal fluid of cases admitted to the hospital for sleeping sickness are the same as those seen in rats inoculated with the blood of cases of either sleeping sickness or simple trypanosomiasis.

4. The organisms seen in the blood of rats inoculated with trypanosomes from any of the three indicated sources have up to the present shown no differences from those observed in animals infected with *Trypanosoma gambiense*.

We have observed the extraordinarily long forms with prolonged flagella, and the stumpy forms with short flagella described as occuring in animals inoculated with the Gambian parasite.[6]

We have, therefore, no reason to suppose that the organisms seen by us in the Congo are other than *Trypanosoma gambiense*.

References

1. Christy, *The Epidemiology and Etiology of Sleeping Sickness in Equatorial East Africa*, with Clinical Observations, Royal Society Sleeping Sickness Commission, *Report III*, November, 1903.

2. Laveran and Mesnil, *Des Maladies à Trypanosomes, leur Reparition à la Surface du Globe*, Janus, August 15, 1903, pp. 395-402.

3. Bruce, Royal Society Sleeping Sickness Commission, *Report I*, August I, 1903.

4. Castellani, Royal Society Sleeping Sickness Commission, *Report I*, August, 1903.

5. Kruse, *Ueber das Trypanosoma Castellani den Erreger der Schlafkrankheit. Sitzungsberichten der Neiderrhein Gesellschaft f. Natur. u. Heilkunde zu Bonn*, May, 1903.

6. J. E. Dutton and J. L. Todd, *First Report of the Trypanosomiasis Expedition to Senegambia*, Liverpool School of Tropical Medicine. *Memoir IX*.

HUMAN TRYPANOSOMIASIS AND ITS RELATION TO CONGO SLEEPING SICKNESS

HUMAN TRYPANOSOMIASIS AND ITS RELATION TO CONGO SLEEPING SICKNESS

(Being the Second Progress Report of the Expedition of the Liverpool School of Tropical Medicine to the Congo, 1903) *

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THE Expedition arrived at Leopoldville on November 21, 1903. Two of its members who had made a short tour through the Cataract Region arrived a week later. During their journey through this district, in which Congo Sleeping Sickness was said to be extremely prevalent, many cases, with very anomalous symptoms, but called sleeping sickness, were seen. As already stated in our *First Progress Report*[1] trypanosomes were found in the peripheral blood of some of these cases. It therefore became necessary to commence a clinical study of human trypanosomiasis in order to see what relation it bore to Congo Sleeping Sickness.

Leopoldville offered particular advantages for such a study, and the members of the expedition decided to remain there for a few months. A large bungalow was placed at their disposal by the Congo government, and through the kindness of Dr. Grenade, the State Medical Officer, and Dr. Broden, Director of the Leopoldville Bacteriological Institute, the patients at the native hospital, a good proportion of whom were infected with trypanosomes, were given to the expedition to study. In addition to this the presence of about two thousand state employees—labourers, soldiers, etc.—afforded an easily accessible, healthy, native population.

Later, the hospital for natives was found unsuited for a complete examination of the cases, and a new structure was built and supplied with the necessary appurtenances through the kindness of the local government. The members of the expedition have therefore for four months been in a position to keep patients under continued and careful observation.

* Received for publication, May 23, 1904.

1. *British Medical Journal*, January 23, 1904.

The following table indicates the results of examinations of cover-slip preparations of finger blood taken from four hundred and sixty-five natives at Leopoldville. The results of similar examinations, made in the region lying between Stanley Pool and the sea, are appended in order to present a concise idea of the prevalence of human trypanosomiasis in the Congo :—

Class of Native	Number examined	Number with Trypanosomes in Finger Blood	Number of Cases with Trypanosomes previously diagnosed as sleeping sickness
Healthy labourers, prisoners, women, and children, all resident for varying periods in or near Leopoldville, but many of whom are natives of distant parts of the Free State ...	255	6	0
Outpatients visiting the clinic of the State Doctor at Leopoldville and chosen for examination because of their miserable appearance	53	3	2
Patients admitted by State Doctor to native hospital	157	45	34
Total for Leopoldville	465	54	36
Total of previous examinations at Boma, Matadi, and in the Cataract Region .	707	49	21
Totals	1,172	103	57

In the British Colony of the Gambia only six cases of human trypanosomiasis were found among 1,043 natives.[1] These cases presented no definite symptoms of illness and nothing abnormal was detected, with the possible exception of an occasional rise in temperature and increase of pulse frequency.

In the Congo we have also seen examples of the mild Gambian type, but the majority of our cases have shown marked symptoms of illness. From a close study of these cases it becomes evident that there is no well-defined line of demarcation between these two forms of the disease, though for descriptive purposes we propose to consider them under three main headings, A, B, and C :—

Type A. Cases with no definite symptoms of illness.

„ B. Cases with few symptoms.

„ C. Fatal cases showing well-marked symptoms, the most notable being fever, lassitude, weakness, and wasting.

1. Dutton, J. E., Todd, J. L., *First Report of the Trypanosomiasis Expedition to Senegambia* (1902), Liverpool School of Tropical Medicine, Memoir XI.

It is significant to note that a large percentage –thirty-six out of forty-four of those classed under types B and C—were believed by their friends to be suffering from 'sleeping sickness.'

We have seen cases coming under type C in which no sleep symptoms were ever present, as well as cases in which some of the diagnostic signs of classical sleeping sickness were noted.

We therefore subdivide type C into :—

1. Fatal cases showing no sleep symptoms.
2. Fatal cases showing sleep symptoms.

Here again no sharp division is possible between these two groups, still, we think it not inadvisable to separate them, since, from our experience here we believe that altogether too much prominence, as a diagnostic feature, has been given to what appears to us to be only a minor and inconstant feature of this disease, namely sleep. The prominence given to this symptom has tended to disguise the true nature of Congo Sickness which is, primarily at least, a trypanosome infection.

The following charts and abstracted clinical reports will illustrate the characteristics of the Congo disease.

TYPE 'A'

Cases with no Definite Symptoms of Illness

Case 79. Fariala. Male. Age thirty.

History.—Admitted to hospital for chronic ulcer of thigh, January 7. Is from Lukila, Kasai district ; has been for ten years in the neighbourhood of Leopoldville.

January 17. General condition. Is a well-nourished, sturdy man ; intelligence good, answers questions quickly and well, shows no unsteadiness of gait, and complains of nothing save the ulcer. Skin is dry and dirty ; there are several large scars and cicatrices on knees, ankles, and elbows, said to be due to injuries and burns. Face is pitted by smallpox. Slight oedema of right shin, probably due to old cicatrix.

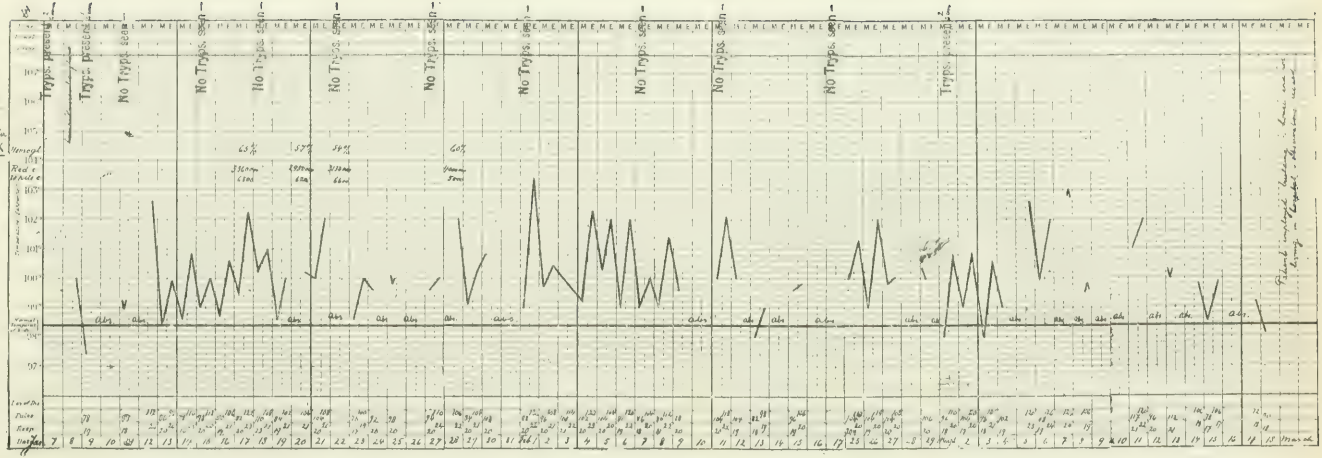
Lymphatic glands are all enlarged. Circulatory system : heart, position and dulness normal, loud mitral systolic bruit, aortic second sound accentuated. Respiratory system : normal. Alimentary system : tongue, teeth, and mouth normal ; bowels regular.

Liver and spleen not enlarged. Nervous system : co-ordination perfect, superficial and deep reflexes normal, pupils react to accommodation and light.

January 25. Complains of nothing, and, save for ulcer, seems quite well. Blood shows filaria diurna, filaria perstans, and trypanosomes.

March 31. Patient at work, and apparently in good health.

CASE LXXIX


Disease
Malaria.
Case LXXIX
Trypanosoma present
No Trypanosoma seen
Urinogl
Rectal temperature
Pulse
Respiration
Date

Case 94. Kassongo. Male. Age twenty-three.

History.—A Batetela man. Has been for two years in Leopoldville as State labourer. Patient says that he never had fever.

February 23, 1904. General condition: Is a well-nourished, intelligent man, answers questions quickly and well. Has a stolid expression, but no dulness or vacancy whatever, actions not markedly slow. Oedema absent, no puffiness of face. Skin smooth and glossy. Lymphatic glands, all easily palpable, freely movable and hard; parotids enlarged. Patient believes himself to be in perfect health. A careful physical examination reveals nothing abnormal in thorax or abdomen.

Nervous system. Co-ordination and sensation to touch and pain normal; superficial and deep reflexes, normal; pupils react to accommodation and light; no tremors.

March 31. Physical examination repeated. With exception of a distinctly accentuated aortic second sound patient seems to be absolutely normal. He works willingly and well all day long.

TYPE 'B'

Cases, Intermediate Between Types 'A' and 'C,' showing very few signs of Illness, and not yet Definitely Believed by Their Friends to be Suffering From Sleeping Sickness.

Case 46. M'Pangila. Age seventeen. Male.

History.—Patient is a Lower Congo native. At age of thirteen he was admitted to the Baptist Mission Station at Wathen, Cataract Region. Here he was successively employed as garden boy, table boy, goat herd, and at the age of fifteen as cook. In December, 1902, he complained of fatigue while on the march, and was soon after dismissed because of untidy careless habits. His employers had at this time only a vague suspicion that these might be the prodromal symptoms of sleeping sickness. He had not since been seen until November 13, 1903; when, with another youth, he carried into the Mission a sick child from a village four-and-a-half hours distant. The only changes perceived in the lad were that much less care was taken of his personal appearance than formerly, and he was not so robust.

November 14, 1903. General condition. Patient is thin and has a certain, apathetic stolidity or dulness of expression. Oedema absent. Skin is soft and clean but dry. Lymphatic glands all considerably enlarged. Physical examination reveals nothing abnormal. Pulse, 96-110. Respiration, 20-24.

Temperature, with the exception of an evening rise to occasionally 99·5° F., is almost normal. Patient was sent to England, December 4, 1903. His condition since he has been under observation in Liverpool has not yet been ascertained.[1]

1. August, 1904, condition [illegible]

Case 5. Mokoko. Male. Age twenty.

History.—Patient is a lower Congo native, and comes from a district in which sleeping sickness is present. He left his village a year ago, and has since been employed on a steamer plying on the Upper Congo. November 18, 1903, was admitted to hospital as a possible case of sleeping sickness. He says his illness commenced about the middle of September, with pain in his chest and knees, and a watery diarrhoea, no blood. These symptoms still continue.

December 12, 1903. General condition : Patient is very thin, muscles wasted. He is very weak and can only stand or walk with difficulty. He lies by the fire all day long without sleeping, and when spoken to insists that he has not 'sleeping sickness.' He complains of diarrhoea, and pain and tenderness in both hypochondria and epigastrium. There is no marked oedema. Skin is dry and dirty, slight 'craw-craw.' Lymphatic glands all slightly enlarged and hard. Respiratory system, slight bronchitis. Circulatory system, heart normal. Abdomen, distended and resonant. Liver, lower border not easily made out, apparently normal. Spleen, normal. Nervous system, co-ordination and sensation to touch and pain normal. Reflexes, superficial and deep, obtainable ; each muscle contracts to flicking ; pupils react to accommodation and light. Patient's condition seems to be wholly due to dysentery and bronchitis.

December 27. Functional murmur at pulmonary second sound.

January 5. Yesterday patient's blood showed over two hundred trypanosomes to the cover. His abdomen was distended and his feet oedematous, but there was little complaint. To-day the parasites are, perhaps, three times more numerous, the abdomen is more distended, and the feet oedematous. Patient complains of headache, pains in his joints, and of the abdominal distention. During these two days he has been more irritable, his breathing has been rapid and his skin moist. No murmurs.

January 6. No trypanosomes in blood, symptoms much alleviated. With the exception of the last two days patient has for some time been in much better condition than when he was admitted.

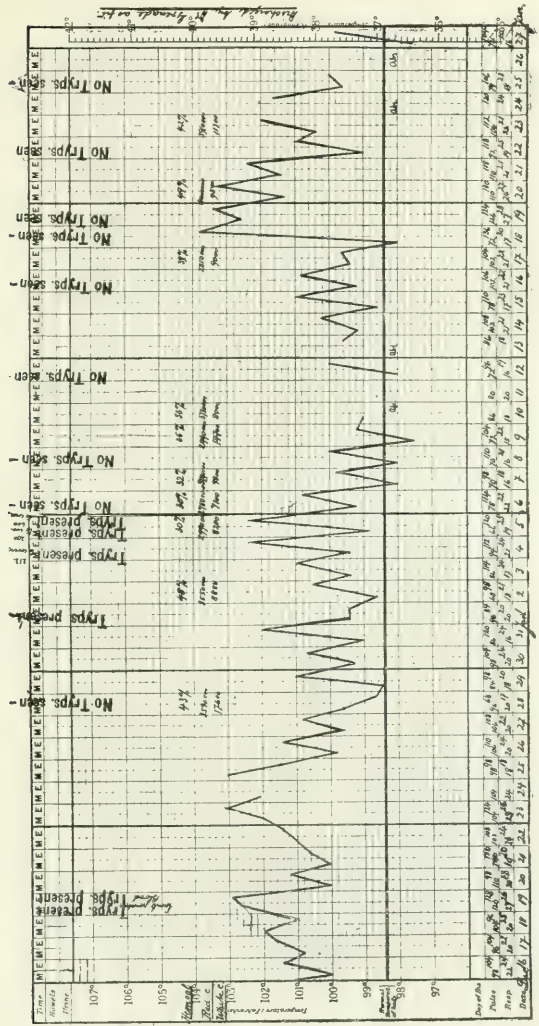
Faeces contain ova of *Anchylostoma duodenale*, *Ascaris*, and *Trichocephalus dispar*.

January 18. There is no oedema. Abdomen is distended and partially tympanitic. He complains of headache, but is otherwise comfortable. Is much stronger and strolls about.

January 28. Observations ceased, allowed to leave hospital.

February 13. Patient seen walking about with steady gait and with exception of abdominal distention and slight wasting, appeared to be well and expressed himself as such.

CASE LXV


DISEASE.
Notes of Case
Name Mokeke
Age 14 years
Date Ende Sabango
Case Book N° LXV
Trypanosomes present
No Trypanosomes seen

TYPE 'C'

Cases Showing Well-Marked Symptoms.

The two following cases illustrate sub-group 'I' of this type. Fatal cases showing no sleep symptoms.

Case 82. Kimfuta. Female. Age eight.

History.—Patient is a Lower Congo native, and comes from a village four hours' march from Leopoldville. When brought to Leopoldville three months back she was an orphan and destitute, and a fortnight ago was sent to hospital, more through lack of friends to look after her than because of any suspicion of sleeping sickness.

December 29. General condition. Patient is miserably thin, and has the appearance of being half starved. She is very weak, her feet are full of chiggers, and she can only walk with difficulty. She has a dazed expression, and is constantly trembling. Tremors are increased on the slightest exertion.

Conjunctivae are congested and there is a slight purulent secretion. Intelligence is good, answers questions quickly and well. Skin, dry, imbricated, and filthy. Lymphatic glands, all easily palpable and hard, save femorals, which are much enlarged, soft, and matted together. The child complains of backache, and insists that she has sleeping sickness, but her condition is thought to be due mainly to starvation and ill-treatment. Circulatory system, normal. Respiratory system: slight bronchitis. Liver, normal. Spleen, just palpable. Alimentary system: tongue heavily coated, teeth tartrous, gums healthy, appetite excellent, abdomen flat and hard. Nervous system, reflexes all increased.

January 8. In spite of attention, cleanliness, and better food, patient is going down hill.

January 16. Greatly emaciated, tremors increased, patient can hardly stand and cannot walk, speech is thick but coherent. There is no drooping of lids, but eyes are fishy and vacant; intelligence is now very dull; she whines and complains on being disturbed; eats little; is seldom asleep, although she is always lying down, and passes faeces under her.

January 19. Emaciation extreme, is too weak to rise, lies with wide-open mouth and eyes, whines, moans, or attempts to speak if touched.

January 20. Spleen punctured, only a few parasites seen, although blood contained 100 to cover. Died during night.

January 21.

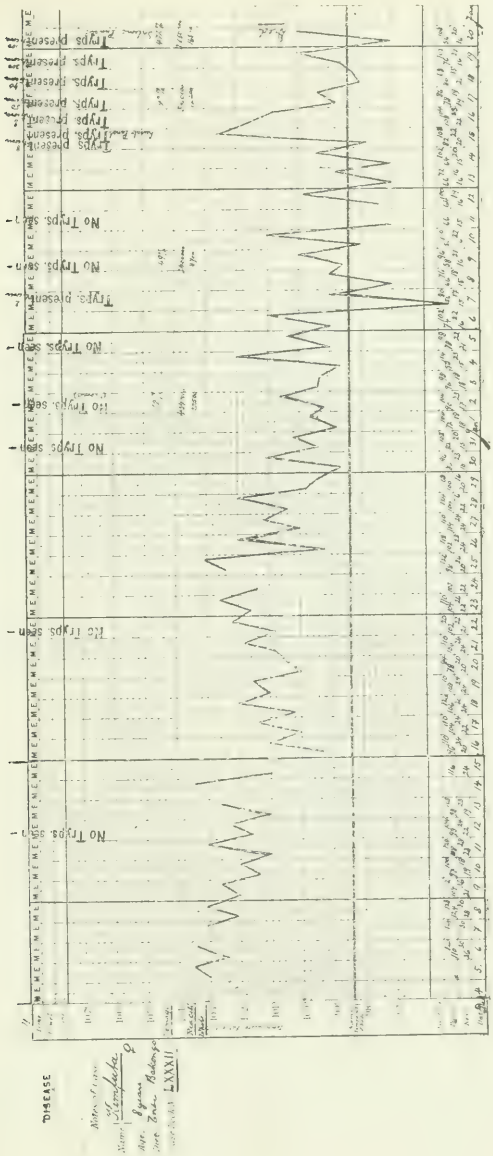
Necropsy commenced at 7 a.m., nine hours after death. Body much emaciated. No bed-sores, nor oedema. Ring-worm of scalp. Mouth foul, pyorrhoea alveolaris, teeth irregular, second dentition.

Thorax: Pleurae normal. Diaphragm: Right side, fourth space; left side, fifth rib.

Lungs: Left lung normal; right lung, old adhesions of upper and middle lobes.

Pericardium contained 5 c.cm. of turbid yellow fluid, in which no trypanosomes were found.

CASE LXXXII



Heart dilated, both sides contained large, firm, white agonal clots. Valves normal. In left ventricle was small area of sub-endocardial petechial haemorrhage. Several pin-head calcareous nodules along cardiac veins.

Lungs: Weight, right, 227 grammes; left, 151 grammes. Both show profuse sub-acute bronchitis; bronchi full of mucous.

Abdomen: Omentum drawn up and wrapped around spleen, small clot of blood between it and outer surface of spleen due to puncture. Peritoneum contained no fluid. Old adhesions between transverse colon and gall bladder.

Liver: Weight, 682 grammes. Yellow, slight interlobular congestion. Gall-bladder full of dark-green semi-fluid bile.

Spleen: Weight, 228 grammes; enlarged, anterior border very much notched; substance very diffluent and dark red in colour. One small spleniculus.

Kidneys: Weight (together), 151 grammes; normal. Bladder normal, filled with urine.

Genitals normal, save for left tube bound down in Douglas' pouch by firm fibrous adhesions. Child has menstruated, remnants only of hymen.

Intestines normal, few anchylostomes in ileum.

Bone marrow (tibia), reddish orange in colour.

Brain: Dura not adherent to calvarium or pia. Superficial brain vessels much congested, vessels of basal ganglia very much so. There was fair amount of colourless, slightly turbid, sub-dural and sub-arachnoid fluid. Similar fluid occurred in ventricles and escaped from vertebral canal. No trypanosomes were seen in these fluids.

Lymphatic glands: Generally much enlarged, often oedematous, usually greatly congested and, in the abdominal and thoracic groups, haemorrhagic, sometimes excessively so. There were numerous patchy areas of dark sub-capsular pigmentation in the femoral and axillary groups.

Case 64. Dysiki. Female. Age twenty-six.

History.—Patient is from Lusambo, in the Kasai district, where sleeping sickness is said to be prevalent. She has been in Leopoldville for two-and-a-half years. Her illness is said to have commenced one-and-a-half months ago. Entered hospital because 'feet were sick and had difficulty in walking.'

December 8. General condition. Patient is very thin, expression somewhat dull and vacant, intelligence good, answers questions fairly quickly, muscles are wasted, and great weakness is apparent in her unsteady walk; speech clear, but weak; eyes very prominent; lips puffy, dry, and cracked. Skin is dry, dirty, and scurfy. There is distinct pitting of shins and dorsa of feet but not of face or forehead. Lymphatic glands, all enlarged. Physical examination of abdomen and thorax showed no abnormality. Nervous system, co-ordination and muscular sense good, reflexes only just obtainable. Alimentary system: tongue steady, slightly furred, teeth and gums normal, appetite good, bowels regular.

December 15 to 19. Patient is very weak, sits most of the day outside the hut. Sleeps but very little, likes to sit in the sun.

December 21. Extremely weak, passes faeces in blanket without changing position. Prominence of eyes (ocular tension increased) and puffiness of eyelids and lips persists.

December 24. Patient in same state, helpless but conscious. Died during the morning.

Necropsy commenced one-and-a-quarter hours after death. *Rigor mortis* just commencing. Body thin, muscles wasted, eyes prominent, both pupils dilated (especially right). Oedema of shins, feet, and forehead. Marked cutaneous thickening of eyelids. Many chiggers in feet. Tongue bitten through, clenched between teeth (no history of a fit). Body very warm ; had been lying in sun, skin blistered. Panniculus scanty.

Thorax : Right pleura, few fibrous adhesions at base of lung. Left pleura, showed three small sub-pleural haemorrhages along vertebral column at level of fifth dorsal vertebra.

Pericardium contained 100 c.cm. clear yellow fluid.

Heart : Weight, 341 grammes ; fat, oedematous, valves normal, muscle pale, patchy thickening of endocardium of left ventricle, vessels normal.

Lungs : Slight bronchitis, oedematous. Weight : Right lung, 226 grammes ; left, 454 grammes.

Abdomen : Peritoneal cavity contained about 2 c.cm. clear fluid. Colon at level of umbilicus ; all abdominal blood-vessels turgid ; very extensive old fibrous pelvic adhesions ; several small broad ligament cysts full of clear fluid ; firm fibrous adhesions of liver and spleen to parietes.

Liver : Weight, 1,818 grammes : distinctly fatty, capsule over surface thickened. Gall bladder full of dark green fluid bile, ducts patent. Between liver and diaphragm was a layer, 5 c.cm. thick, of colourless gelatinous oedema.

Spleen : Enlarged and gorged with blood, substance soft and friable.

Kidneys, together, weighed 250 grammes, both showed cloudy change, capsules were adherent, and there was congestion of venae stellatae and around pyramids.

Pancreas and suprarenals normal.

Alimentary system : Mouth foul, gums soft, stomach normal, intestines normal, anchylostomes in jejunum.

Genitals : Vagina, slight mucous and cellular discharge, containing *Trichomonas vaginalis* and various bacteria ; no acute inflammation. Uterus nonparous, sub-acute metritis. Left ovary partially fibroid. Right ovary normal; no signs of recent inflammation in tubes.

Bone marrow (femur) : Very dark reddish orange.

Brain : Dura not adherent ; superficial vessels congested, but not so much as in many of the cases ; sub-arachnoid fluid not greatly increased and only slightly turbid ; ventricles contained a few c.cm. of yellowish, slightly turbid fluid, ependymal vessels congested ; no haemorrhages seen ; spinal cord vessels turgid.

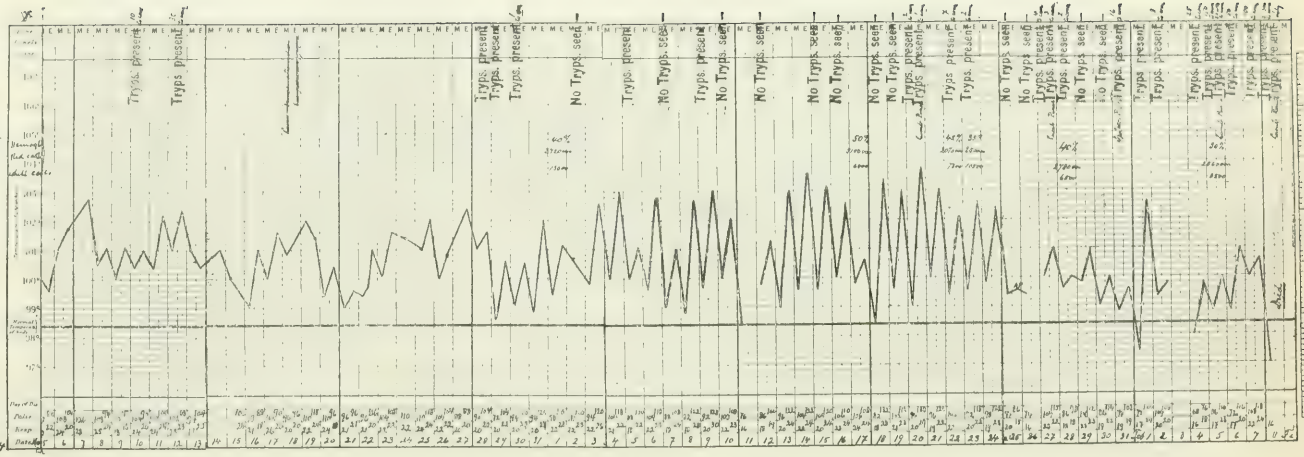
Lymphatic glands were nearly all enlarged, watery, and often congested. Some of pelvic and lumbar glands were chocolate colour and almost diffluent ; a small gland size of pea in much the same condition, but not diffluent, was found lying on head of pancreas. No actual haemorrhages into gland substance were seen. Fluids from pericardium, glands, receptaculum chyli, and oedematous tissues were examined, but no trypanosomes were found.

The following cases illustrate sub-group '2' of Type 'C.' Fatal cases showing sleep symptoms.

Case 62. Jeri. Male. Age eleven.

History.—Is a native of Irebu, a town near Lake Tumba, where sleeping sickness is said to be present. Left his village two years ago and has since lived in or near Leopoldville. He has been in hospital for one-and-a-quarter months. Was 'boy' to a white man who sent him to hospital as a suspected case of sleeping sickness. When

CASE LXII


DISEASE
Name Jerry
Age 11 years
Book Entd. Feb.
Case Book N° LXII
Tryps. present
No Tryps. seen
Date of Admission
C 23.10.03
Result Death 8.2.04

first seen on November 23, patient was a thin, sharp-witted lad, and denied that he had sleeping sickness, but was said by his companions to sleep a great deal.

December 11, 1903. General condition. He is a weak emaciated boy; intelligence good; answers questions quickly; no thickness of speech; no unsteadiness of gait; is a mouth breather, and his 'adenoid look' gives him a certain vacancy of expression. Skin is dry and scurfy and covered with early 'craw-craw.' Muscles wasted; mucous membranes anaemic; lymphatic glands all enlarged. Circulatory system, normal. Respiratory system, slight bronchitis. Alimentary system, tongue steady, slightly coated, teeth and gums covered with tartar. Liver, 1 cm. below ribs. Spleen, 2·5 c.cm. below ribs, not tender nor painful. Nervous system, reflexes normal; pupils react to accommodation and light; co-ordination and muscular sense, normal.

December 28. Patient still answers questions quickly and well, has no pain nor headache, complains of a constant desire to sleep, but is seldom seen sleeping. Heart: reduplication of first apical sound. No oedema. Ocular tension is very distinctly increased, and the eyes are prominent. Knee jerks exaggerated, tendon reflexes not obtainable. He is able to go some distance from the hospital to collect firewood to cook his food. His inordinate appetite has become the joke of the hospital.

January 19. Patient now sleeps most of the day, or sits dozing over his fire with his head drawn back and his mouth wide open.

January 21. Is too weak to walk about, but lies in the hut complaining and talking of his weakness.

January 25. Sleeps much more than previously and is becoming, if possible, more emaciated. Is easily roused when touched.

February 2. Is vivacious and talkative again. When lying down or dozing over fire, head is drawn back and chin protruded to utmost as noted on January 19.

February 5. Is much worse again, apparently dying, lies curled up on his side, and is roused with difficulty.

February 8. Dying, almost pulseless, Cheyne-Stokes respiration, lies on back in an extreme state of opisthotonos, with legs extended and head drawn back to such an extent that two fists, one above the other, can be passed beneath him. Died at 7 p.m.

Necropsy commenced one-and-a-quarter hours after death. Body much emaciated, still warm. Slight oedema of forehead, shins, and dorsa of feet.

Thorax: Pleural cavities normal. Pericardium contains 100 c.cm. of clear yellow fluid in which were seen divisional forms of trypanosomes.

Heart: Weight, 226 grammes, normal.

Lungs normal.

Abdomen: No fluid, old firm fibrous adhesions of right lobe of liver to parietes.

Liver: Weight, 610 grammes, slightly congested, otherwise normal. Gall bladder full of dark thick bile. Ducts patent.

Kidneys: Right showed marked peri-pyramidal congestion.

Spleen: Weight, 266 grammes. Slightly enlarged, substance firm, not slatey.

Pancreas and suprarenals normal.

Intestines contained very many ascaris, anchylostomes, and a few *Trichocephalus dispar*.

Bladder showed two submucous haemorrhagic areas near meatus.

Genitals normal.

Lymphatic glands : Generally enlarged and watery, especially the abdominal groups, some of the latter were deeply congested ; one gland lying on the anterior surface of the pericardium had a distinctly haemorrhagic centre.

Brain : Slight congestion of superficial vessels and flattening of convolutions ; sub-arachnoid fluid in excess, 'ground-glass appearance' of arachnoid. *Cord* : vessels congested, great increase in cerebro-spinal fluid.

None of cranial bone cells were abnormal.

Living trypanosomes were seen in preparations made *post-mortem* from finger blood and pericardial fluid, but not in heart blood.

Case 84. Moidi. Female. Age twenty-four.

History.—Is a Kasai woman. Has been living for past two months near Leopoldville. Was sent to hospital, January 12, as a case of sleeping sickness.

January 21. Patient is a big well-made woman, no emaciation, her expression is dull, pained, and stupid, almost vacant. She is continually making grimaces. She cannot walk and lurches forward in a half drowsy condition during examination. Speech is thick and slow. Oedema of shins and feet, face and lips puffy. Indeed, the whole body is more or less puffy and presents an appearance of plumpness. Skin dry and dirty. There is a very extensive cicatrix, from a burn, implicating the right arm, side, and thigh. Lymphatic glands not enlarged. Circulatory and respiratory systems normal. Alimentary system, tongue coated and moist ; teeth and gums foul. Tip of tongue only, after much persuasion, protruded. Liver normal. Spleen slightly enlarged.

January 25. Patient usually sits dozing over a small fire. She is occasionally found lying at full length, naked, on the floor, or asleep in an uncomfortable attitude on the board bed. She can be easily aroused by a touch, and can, by shouting, be persuaded to speak.

February 5. Patient is almost lethargic, and is aroused only with some difficulty. She now eats nothing and is becoming emaciated. Sensation is dulled ; hardly flinched during lumbar puncture.

February 6. Died early this morning.

Necropsy six hours after death. The body of a massive but wasted woman. *Rigor mortis* present in masseters and extremities. Panniculus in fair amount.

Abdomen normal. Diaphragm : Right side, upper border fourth rib ; left side, fifth rib.

Thorax : Pleurae normal.

Pericardium contained a small amount of yellowish fluid.

Heart : Weight, 342 grammes ; contained firm white agonal clots.

Lungs : Weight, right, 454 grammes ; left, 335 grammes ; slight bronchitis and hypostatic congestion.

Liver : Weight, 1,591 grammes ; light in colour, central lobular congestion, soft and friable. Gall bladder full of dark, thick bile. Ducts patent.

DISEASE

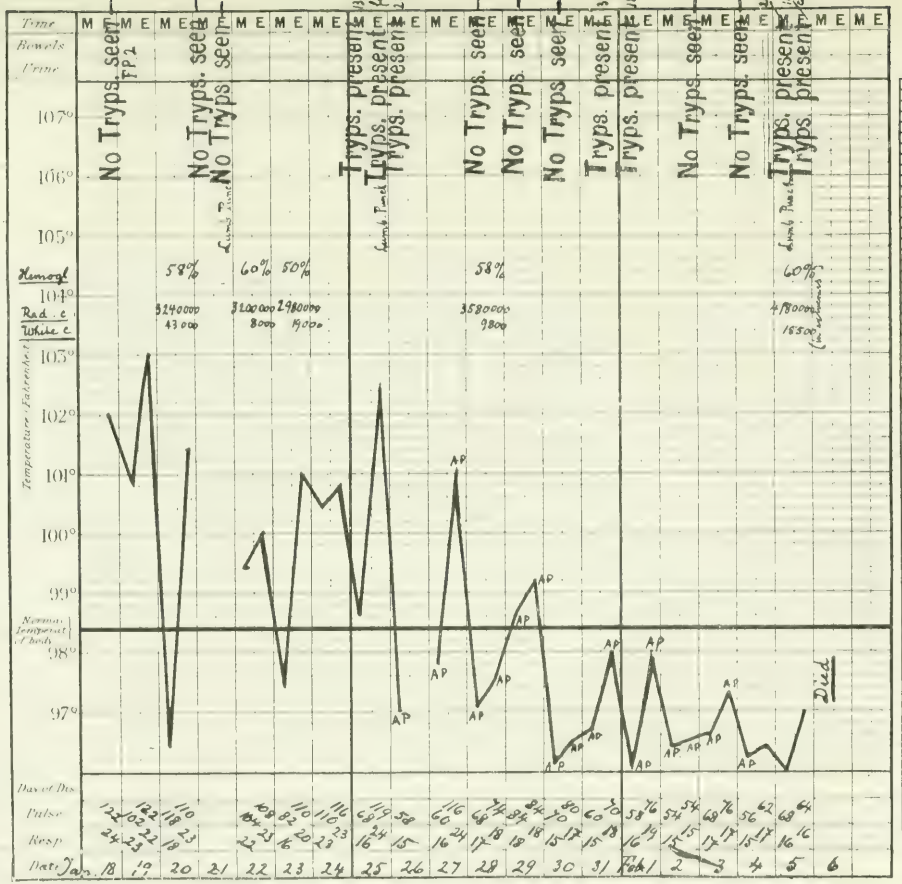
Notes of Case

Name Moidi

Age. ♀

Diet

Case Book N° LXXXIV



Date of admission
Jan. 12 1904

Result Death Feb. 6

Spleen : Weight, 345 grammes ; measures 22 × 10 × 4·5 cm. ; substance firm, slightly fibroid.

Kidneys : Weight together, 338 grammes, normal.

Genitals, with exception of chronic vaginitis, normal. Mouth foul with sores. Intestines contained a few anchylostomes and *Trichocephalus dispar*. Alimentary canal otherwise normal.

Brain : Vessels all much congested, sub-arachnoid fluid increased and turbid. Microscopically cerebro-spinal fluid showed pus cells but no trypanosomes.

Lymphatic glands all much enlarged. Retro-sternal and mesenteric glands slightly injected. Decomposition had commenced in retro-peritoneal glands. Femoral and inguinal glands congested and in one or two of the latter pus formation had commenced.

The two following cases, not easily classable under the foregoing headings, are, we think, of interest, as they illustrate the extremely rapid course the disease occasionally takes after symptoms have once developed.

Case 69. Kabali. Female. Age twenty-six.

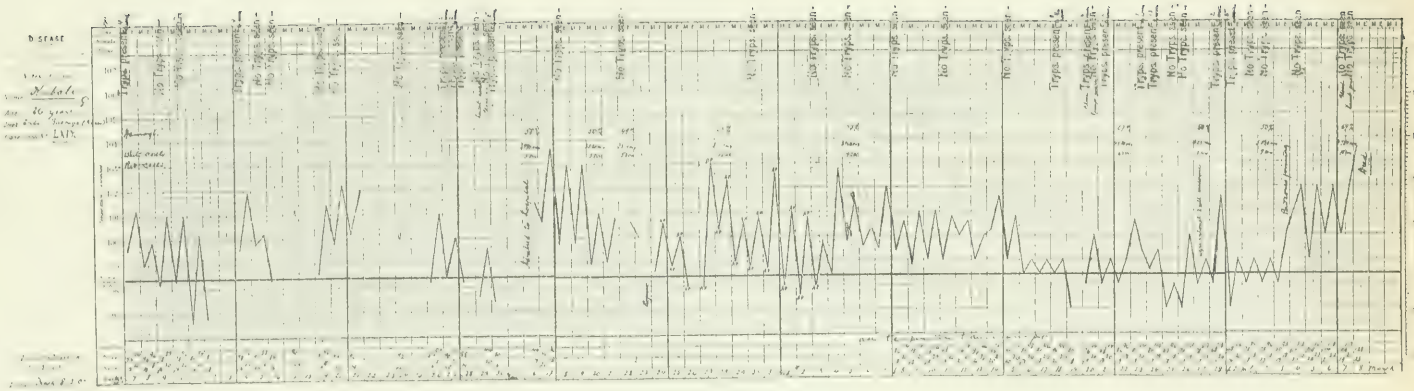
History.—Patient comes from the Kasai district, and left her native village, which is four days distant from Lusambo, ten years ago. Since then she has been in many places along the Upper Congo. Has lived in Leopoldville for the last two or three years.

When first seen on December 7, 1903, she stated that her illness had commenced four months previously, and began with rigor and fever ; the left side of her head swelled and was painful. There was no sore nor evacuation of pus. This condition lasted for six weeks. She says that she has since become thinner and weaker, particularly during the past two or three weeks. She has lost her appetite and has a tendency to diarrhoea.

December 25, 1903. General condition. Patient is a tall, well-developed woman, but thin, and her muscles are flabby. She is less active and vivacious than when first seen, and has a tired, listless gait. Her expression is rather dull, but she is intelligent and answers questions quickly and well. She speaks without hesitation or thickness. Complains of pain on pressure on shins. Skin is very abnormal. It is clean, though dry, and gives a rough feeling to the touch. This is most marked on shoulders, arms, and extensor surfaces of thighs and legs. In the parts most affected the skin has somewhat the appearance of an early exfoliative dermatitis, in which patches of glazed and thinned skin desquamate, slightly, at their edges along rectangular cracks and furrows. There is no itching nor discomfort, and the condition seems to be recent. At some spots are areas of crumpled tissue-paper-like wrinkles. No oedema. Lymphatic glands all enlarged. Tongue furred, moist, and steady. Circulatory system, pulmonary second sound is very much accentuated. Respiratory system normal. Liver normal. Spleen, considerably enlarged. Nervous system, co-ordination and muscular sense, normal ; reflexes, normal ; pupils react to accommodation and light, mental condition, alert.

January 18. Patient was admitted to hospital two days ago as a case of sleeping sickness. She is much thinner and weaker. Expression dull and sleepy. Skin

CASE LXIX



condition less marked; tongue coated and dry but steady; complains of sleepiness and dozed during examination.

January 25. Lies in bed all day, is drowsy but does not sleep much, is irritable and querulous.

February 2. Seldom asleep, and then at once aroused, is bright and intelligent; complains of pains 'all over' and of insomnia at night; staggers with weakness on attempting to walk.

February 12. Is much weaker, can hardly walk; speech is thick, weak, and monosyllabic; lips flabby and glued together; sleeps a good deal but easily aroused.

February 16. Lies in a drowsy condition all day; complains that she cannot walk. Food is brought to her, but unless assisted she does not eat.

February 24. Sleeps lightly all day; is almost too weak to sit up alone; calls for assistance to go to stool.

March 7. Pulse rapid and weak; patient has not slept during night; complains of pains all over; cries out when touched, owing to bed-sores forming on sacrum and scapulae; pupils equal and widely dilated; axillary and femoral glands enlarged, but not nearly so large as when admitted to hospital; cannot take her food, either milk or soup. Knee jerks increased; arms persistently flexed at elbow; hands tremulous. No oedema.

March 8. Died 4 p.m.

Necropsy commenced three-quarters of an hour after death. Body much emaciated; bed-sores over sacrum and both scapulae; skin clean, dry, and shows slightly on extremities the previously noted 'imbricated appearance.' No oedema; pupils widely dilated, left slightly more.

Thorax: Left pleura contained 30 c.cm., very turbid fluid with floating flakes of lymph, right pleura contained 10 c.cm. of similar fluid. Pericardium contained 40 c.cm. slightly turbid yellow fluid.

Heart: Weight, 223 grammes; normal; full of firm clot.

Lungs, each weighed 231 grammes. Marked hypostatic congestion, with sub-acute bronchitis of both lungs. At posterior border of left lung, level of seventh dorsal vertebra, there was a recent deposit of fibrous lymph on pleura, with intense subjacent congestion.

Abdomen: Peritoneum dry, mesenteric vessels congested; spleen and liver adherent to parietes and adjacent organs by fairly extensive, old, fibrous adhesions.

Liver: Weight, 1,585 grammes, large, nutmeg, with commencing fatty change.

Gall bladder filled with thick grumous bile.

Spleen: Weight, 335 grammes, $19 \times 11 \times 4.5$ c.cm. Anterior border deeply notched, substance dark, firm, but friable.

Kidneys weighed together 225 grammes, normal.

Pancreas and suprarenals: Normal.

Alimentary canal: Mouth, stomach, large intestine, and jejunum normal. A Peyer's patch about 60 cm. above ileocaecal valve was greatly congested. On either side of patch for some 10 cm. were numerous disseminated congested areas, varying in diameter from 1 to 4 mm. Ascaris and anchylostomes present.

Genitals: Uterus small, nonparous small myoma. All genital organs firmly bound together by old adhesions; vagina normal.

Brain: dura easily detached, sub arachnoid space filled anteriorly with thick-formed lymph, posteriorly sub-arachnoid fluid very cloudy and semi-purulent; all vessels moderately congested. About 50 c.cm. turbid yellowish cerebro-spinal fluid escaped on opening tentorium. Cranial bone sinuses normal.

Bone marrow (femur): Very dark and diffluent, like clotted blood.

Lymphatic glands: All retro-peritoneal and pelvic glands very deeply congested; on section, soft, with a good deal of bloody fluid. One or two omental glands in a similar condition.

Glands from the other parts of the body enlarged but otherwise normal. Trypanosomes were not found by coverslip preparations in any of the body fluids or blood.

Case 86. Naiyai. Female. Age twenty.

History.—Patient was sent to us on January 7 by native dispenser at a settlement near Leopoldville. She was said to have recently come from a district in which sleeping sickness was present. She was supposed to be in the 'initial stage' of that disease. Patient was well dressed, clean, and neat. She seemed in good health. She had, however, a peculiar vacancy of expression, and answered questions in an excitable and voluble manner, making grimaces. She stated that she had sleeping sickness, but, as yet, not badly. Patient was kept under observation for two days, but nothing abnormal was noted, save her expression and some display of irritability.

On *January* 24, she was carried into hospital in a listless, dazed, and sleepy condition, unable to walk, and apparently unable to speak.

February 4. General condition: Is a well-nourished woman; expression dull and vacant; manner apathetic and listless. Is able to walk with slow shuffling steps. Intelligence much dulled. Tongue coated and moist, slight tremors. Skin normal. Glands all enlarged save posterior cervical. Considerable oedema of shins and insteps; lips and eyelids puffy. Appetite good. Patient munches her food in a slow way, peculiar to many advanced cases. She frowns continuously. Circulatory, respiratory, and alimentary systems normal.

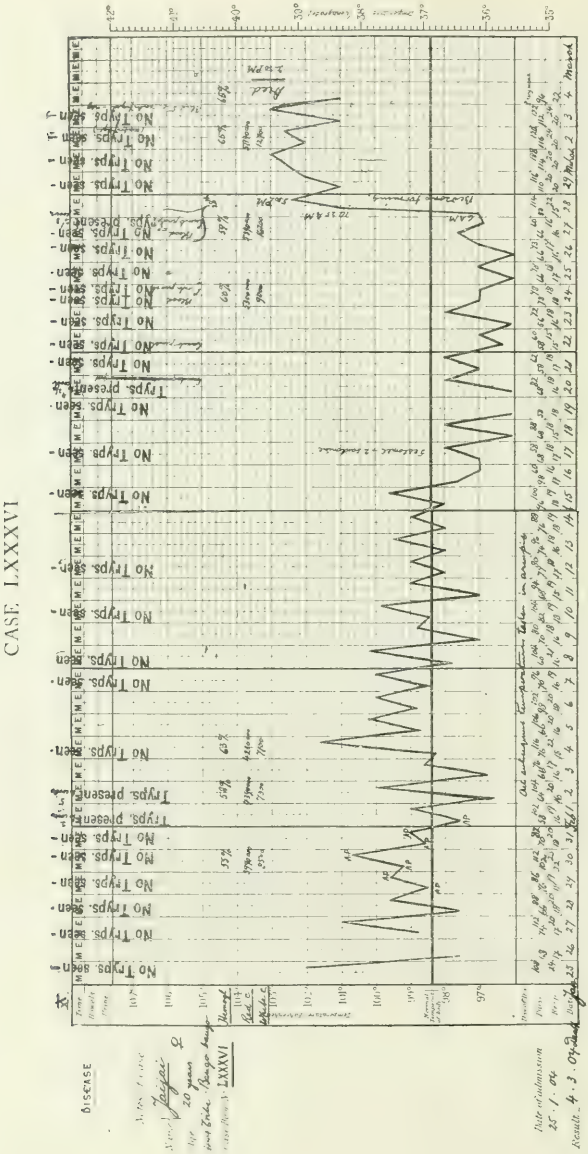
February 10. Sleeps a good deal but is much better than she was, is not so apathetic, and can talk and laugh while eating; appetite good.

February 16. Vacancy of face is again marked; patient is very weak and trembles all over; she speaks in weak voice only after much persuasion.

February 28. Since last note patient's condition has not altered. She has been unable to get off her bed; passes motions into bed; has only been able to take liquid food, and that only with assistance, is usually wide awake and conscious of all her surroundings, and, until now, has shown no very marked signs of wasting. To-day temperature, 102·4 F., profuse perspiration; crepitation and dullness at base of right lung.

March 3. Is now helpless, with sunken eyes and haggard face; body and limbs show marked wasting; oedema of shins and insteps and puffiness of face have disappeared; tremors, which were very marked, have ceased; she cannot take even soup; large bed-sores have formed on either side of sacrum.

CASE LXXXVI


DISEASE
CASE LXXXVI
No Trypanosomes seen
Trypanosomes present

March 4. Patient dying, but perfectly conscious, even acutely observant of all that goes on around her. Died at 2.30 p.m.

Necropsy commenced one-and-a-half hours after death.

Body warm, wasted though not distinctly thin. *Rigor mortis* just commencing, pupils evenly and widely dilated. Tissues dry, panniculus fairly abundant. Muscles normal.

Thorax : Pleurae normal.

Pericardium contained a few drops of fluid.

Heart : weight, 148 grammes, small, muscles pale and firm. Mitral valve showed distinct, reddish, gelatinoid thickening.

Lungs : Weight, right, 300 grammes ; left, 223 grammes. There was slight bronchitis of both lungs and marked hypostatic congestion, the latter condition marked in the right ; vessels contain firm, stratified clots.

Abdomen : Pelvic peritoneum congested and genitals firmly bound down by extensive fibrous adhesions.

Liver and spleen adherent slightly by old fibrous adhesions to adjoining organs and parietes.

Liver : Weight, 1, 582 grammes, slightly nutmeg. Gall bladder moderately filled with golden bile.

Spleen : Weight, 221 grammes, $17 \times 9 \times 5$ cm., upper lobe almost entirely divided by deep indentation from lower, substance dark, firm, friable.

Kidneys : Weight together, 218 grammes, normal.

Pancreas and suprarenals : Normal.

Alimentary Canal : Normal.

Bladder : Normal.

Genitals : Uterus small, non-parous, metritis with acute intense cervicitis ; fallopian tubes and ovaries bound down to uterus by old adhesions, acute vaginitis.

Bone marrow (femur) : Reddish brown.

Brain : Superficial vessels congested, particularly over posterior half of hemispheres (patient lying on back for several days before death). Relatively small amount, though increased, of sub-arachnoid fluid ; no ependymal haemorrhages ; about 30 c.cm. cerebro-spinal fluid escaped on cutting tentorium. Cranial bone sinuses normal.

Lymphatic glands : Retro-peritoneal and pelvic glands were enlarged ; the latter group being congested; the remaining groups of glands were normal.

In this attempt to illustrate the course of sleeping sickness, as found in the Congo, we have tried, as far as possible, to exclude from the illustrative cases those in which obvious secondary lesions were demonstrated *post-mortem*. It will be seen that deep sleep, continued sleep and lethargy, symptoms described as characteristic of sleeping sickness, are not features of the Congo disease as observed by us up to the present.

Trypanosoma Gambiense as a Probable Cause of Congo (Sleeping) Sickness

(*A*) As already indicated, in nearly every case in which sleeping sickness was diagnosed, or suspected, trypanosomes have been found in either blood, cerebro-spinal fluid, or both.

(*B*) We have shown that there is a very evident clinical connexion between those cases which have only very slight symptoms ('Trypanosoma fever') and the advanced cases of 'sleeping sickness' seen in hospital.

(*C*) In Gambia there is an undoubted trypanosome disease in horses which is characterized, in its first stage, by the absence of obvious symptoms ; and later, by fever, emaciation, and weakness. The course of this disease may be chronic and death delayed for a long period.

We have a horse, in good condition, under observation in Liverpool, which was first found to be naturally infected on October 30, 1902. A letter, dated January 18, 1904, from an officer in Gambia, says that his horse, found naturally infected in April, 1903, 'could not be better, and is in excellent condition.'

This Gambian horse disease seems to present a striking analogy to the human trypanosome disease seen in the Congo. The dull, listless expression, the weakness, the wasting and lack of energy, the irregular elevation of temperature, the frequent disappearance of the parasite from the peripheral blood (to ordinary examination), and the chronic course of the disease, are features characteristic of both infections. The similarity seems to us to be a point in favour of the casual relation of trypanosomes to Congo sleeping sickness.

(*D*) The sleeping sickness of the Congo is known to have a long latent period. Symptoms are said to have developed in some cases two to five years after leaving an infected locality.[1]

It is interesting to note that natives may be infected with trypanosomes for many months without showing signs of illness.

We have just heard that a Gambian native in whose blood trypanosomes were seen over a year ago is still in the very best of health.

Dr. Zerbini, State Physician at Boma, has just sent us a report on cases observed by us in Boma during October last. His report is based on either his own observations or on the statements of heads of departments in those instances in which the cases had passed from his care. The report on five cases is indistinct or vague. Five had been in perfect health during the whole six months. Three have had surgical troubles, but are now well. One has had persistent diarrhoea, but has quite recovered and has been sent to the Upper Congo. Two cases have died of pneumonia, and the remaining four, only one of whom was in perfect health when we saw them, show slight oedema, lack of energy, or some other ailment. In none is there any suspicion of sleeping sickness.

(*E*) Europeans[2,3,4] infected with *Trypanosoma gambiense* show symptoms which are quite comparable with those observed in uncomplicated trypanosome infections of Congo natives.

(*F*) In Gambia, where cases of sleeping sickness are rarely seen (Dr. M. Forde, Principal Medical Officer at Bathurst, stated that perhaps one case a year came under his care), only six out of one thousand odd natives were found to be infected,[5] by the examination of fresh cover-slip preparations. In an almost exactly equal number of a similar class of natives examined in the same way in the Congo, forty-six have been infected In Uganda, where the disease occurred in epidemic form, the percentage of infection among the general population was still higher.[6]

1. G[illegible] VI[illegible], [illegible] 14, Pa[illegible], 1899.
2. M[illegible], [illegible], Mars 28, M[illegible] 1903.
3. Dutton, Todd, Christy, *Brit. Med. Jour.*, January 23, 1904.
4. [illegible] *Coloniales*, Févr., 1904).
5. Dutton, Todd, *Ibid.*
6. Reports of the Sleeping Sickness Commission, Royal Society.

We have not yet met with an epidemic of sleeping sickness in the Congo, although at least one has been recorded.[1] From the answers to inquiries, which we have received from state doctors and officials in different parts of the country, we do not think that the disease exists in any part of the Congo in a much more severe form than at Leopoldville, and certainly there is no epidemic comparable to that in Uganda.

It will be noted that the Congo type of case, as we have described it, bears a close resemblance to some of the cases described by Bruce and Nabarro on the Victoria Nyanza, at a time many months after the epidemic wave had passed eastward, and at a place Entebbe, situated at the extreme tail of the epidemic area. Moreover, one of us is able to recognize a similarity between many of the cases seen here, particularly those in which emaciation, lengthened period of illness, and absence of sleep, are the main features, and many of the cases seen by him on Buvuma Island, also situated in Victoria Nyanza, and towards the tail of the epidemic area.[2]

The Course of the Disease

Duration. It has been impossible to decide for how long a period a native may be infected with trypanosomes and still show no definite signs of disease. One man already mentioned, is known to have been infected for over a year and is still perfectly well. It would appear from one or two early cases which have been observed that the transition from this 'latent' stage to one in which symptoms are noticed may be very gradual. We have only observed eight fatal cases of Congo sickness in which the necropsies showed no obvious secondary infection. The duration of the disease, dating from the recognition, either by the friends of the patient or by ourselves, of obvious signs of ill-health, has been from two to four months.

Recovery. In our experience no native who has shown definite and constant signs of ill-health has recovered.

Since we have been in Leopoldville we have frequently seen a case of trypanosomiasis in a European, reported by Dr. Broden[3] and Sir Patrick Manson.[4]

Mrs. M., a missionary stationed at Leopoldville, states that her illness commenced on October 1, 1900, with a fever which lasted for three months and was not amenable to quinine. Since that time she had not been free from constantly recurring fever, except for two periods, in 1901 and 1902, each of three months duration, up to March 19, 1903. Since the last date she has been absolutely free from fever or other signs of trypanosoma infection up to the present (April, 1904). She is apparently in perfect health and has increased in weight. The trypanosomes were found by Dr. Broden on February 7, 1903, during an attack of fever which lasted for a few days. During the last year Dr. Broden has seen no parasites in the blood of this case.

Death. We do not think that we have sufficient evidence to state that death is produced by the trypanosomes alone.

1. Bergh St. Marie in the Portuguese Commission's Report.
2. Christy, Reports of the Sleeping Sickness Commission, Royal Society, No. III.
3. Broden, *loc. cit.*
4. Manson, *loc. cit.*

Secondary Infections and Complications

Secondary bacterial infections seem to determine the fatal issue of many cases of Congo sleeping sickness. Thirteen out of twenty-two necropsies performed at Leopoldville showed complications or obvious secondary infections.

They were as follows :—

Purulent meningitis	4
Purulent pleurisy and pneumonia	1
Pneumonia and localized tubercle of lung	1
Localized gangrene of lung	1
Enlarged caseating and breaking down glands in thorax and abdomen. No tuberculous lesions in organs (tubercle bacillus in glands seen in one case)	2
Dysenteric ulceration of large bowel (perforation in one case) ...	2
Universally adherent pericardium (recent)	1
Infiltration of pus in femoral, inguinal, and internal iliac glands (gonorrhoea)	1

According to the *Post-mortem* Reports of Colonel D. Bruce and Dr. Nebarro very similar lesions were observed in Uganda, where ten out of twenty autopsies on sleeping sickness patients showed obvious secondary infections and in three instances purulent meningitis.

It will be noted that purulent meningitis has been the most frequent complication both in Uganda and in the Congo. The brain in these cases (see case 69) presents a very abnormal appearance. The convolutions, especially on the upper surface, are covered and glued together by a thick layer of tenacious lymph, and the vessels of the pia arachnoid are intensely congested. It is evident that such morbid changes are explicable on bacteriological grounds, and we have found, microscopically, in all such cases an almost pure culture of a diplococcus occurring in small chains. These observations make us doubt whether the acute congestion of cerebral vessels accompanied by an increase of pia arachnoid fluid containing pus cells, seen by us here, and described by others as typical of sleeping sickness, can be attributed to the trypanosome alone.

The Portuguese Sleeping Sickness Commission,[1] Dr. Broden in Leopoldville,[2] and Dr. Castellani in Uganda,[3] have all described bacterial infections in a very large percentage of sleeping sickness cases examined before as well as after death.

It must be noted that such purulent changes have not been described in animals dying from other trypanosome infections.

1. Bettencourt, Kopke, e Rezende and Mendes, *La Maladie du Sommeil*, 1907.
2. Broden, *Ibid.*
3. Castellani, Report of the Sleeping Sickness Commission, Royal Society.

OBSERVATIONS ON THE PARASITE

Periodicity and Frequency of Occurrence in the Peripheral Blood

Frequent examinations of the finger blood of trypanosome cases have shown that the parasites may, to the ordinary methods of examination, be absent from the peripheral blood for varying periods. This periodicity is illustrated by the two following cases :—

Case 101. Oporanga. Regular observations were made about every third day, commencing on January 3, 1904, when no parasites were seen. The periods of presence or absence of the parasite from that date until death were as follows :—

22	days	absent	...	11	observations.
3	,,	present	...	3	,,
7	,,	absent	...	4	,,
3	,,	present	...	3	,,
33	,,	absent	...	14	,,
4	,,	present	...	4	,,
6	,,	absent	...	3	,, Died.

This case shows comparatively long periods of absence.

Unless especially stated the routine method of examination employed for the detection of the trypanosomes was the examination of a freshly made three-quarter inch square, cover-slip preparation of finger blood ringed with vaseline.

Case 90. Bongwendie. Routine examinations commenced on January 19, when trypanosomes were found to be present. They had not been seen for four days previously.

3	days	present	...	3	observations.
9	,,	absent	...	4	,,
6	,,	present	...	4	,,
6	,,	absent	...	4	,,
1	,,	present	...	1	,,
2	,,	absent	...	1	,,
1	,,	present	...	1	,,
5	,,	absent	...	4	,,
2	,,	present	...	1	,,
3	,,	absent	...	1	,,
6	,,	present	...	5	,,
10	,,	absent	...	7	,, Died.

This case shows shorter periods of absence.

In some cases parasites have been almost constantly present in the blood (Case 85); in others, as is shown by the two following cases, they have been rarely found.

Case 77. Ejoli. Under observation for twenty-one days before death. Parasites seen only twice on two consecutive days; sixteen observations.

Case 103. Belamo. Still under observation. Parasites not seen for thirty-eight days; seventeen observations. They have been seen in the blood of this case only by centrifugalizing.

The frequency with which the parasite is obviously present in the peripheral blood bears no relation to the severity of the symptoms.

Number of Parasites Appearing in the Blood

The number of parasites seen in ordinary fresh cover-slip preparations is generally small, but in some patients, very large numbers have been recorded. In two cases a large increase has occurred during the few days immediately preceding death.

Case 87. Patesa. Admitted to hospital for acute dysentery; under observation for four days preceding death. Parasites increased from two to a cover on the first day to twenty to a field on the day of death. There was no accompanying rise of temperature.

Necropsy showed very extensive dysenteric ulceration of the large intestine.

Case 88. Boyo. Parasites increased during the four days preceding death from two to one hundred to a cover. They had not been previously seen in such large numbers. At the necropsy on this case very general enlargement and caseation of abdominal and thoracic glands was noted. There were no tubercular lesions in the lungs or other organs.

A similar increase of parasites occurred just before death in Cases 62 and 82 (see charts); but in the two following cases they were absent for some days before death:—

Case 89. Kapinga. Parasites not seen for ten days preceding death; six observations.

Case 77. Ejoli. Parasites not seen for nineteen days before death; fourteen observations.

Sudden Disappearance of the Parasite from the Finger Blood

The following are examples of cases in which the parasites have gradually increased from small to fairly large numbers (twenty to cover-slip or more) and then suddenly disappeared on the day after their acme was reached.

Case 65. Mokoko. See chart.

Case 99. Mozao. At the end of the first examination on March 5 seven trypanosomes were seen to a field. On March 6, 7, and 8 none were seen.

Case 102. Kondolo. On February 24, seven parasites were seen to a cover; on February 25, seventy to cover; on February 26 and eight following days, none were seen, although observations were made every other day.

A second similar acme and sudden disappearance was recorded in this case. On March 10, six parasites were seen to cover; on March 11, two hundred and fifty; but on March 12, none were found.

Case 90. Bugwendi. On February 26, 27, 29, and March 1, parasites were seen in the following numbers respectively, eight, five, five, and one to a cover. On March 2, twenty-four were seen; but from March 3 to date of death (March 21) they were absent.

Case 101. Oporanga. On March 1, 2, 3, parasites were seen in numbers six, forty-eight, thirty-one, respectively, to the cover-slip. On March 4, one hundred and twelve were noted; but on March 6, 7, and 8, not one was to be found. (No examination on March 5).

Case 66. Tenda. On February 23, 24, and 25, the number of parasites recorded per cover was four, five, and seven, respectively,. On the 26th, seventy to a cover; but on the 27th, and for fifteen subsequent days, none were found.

Case 85. Banja (see below). Illustrates a somewhat opposite condition. The parasites increased in this case to an acme which lasted for two or three days, and then a marked diminution in number was observed. This patient, who is still under observation, illustrates the constancy with which parasites are seen in the peripheral blood of some cases. It will be noted that his general health has latterly improved.

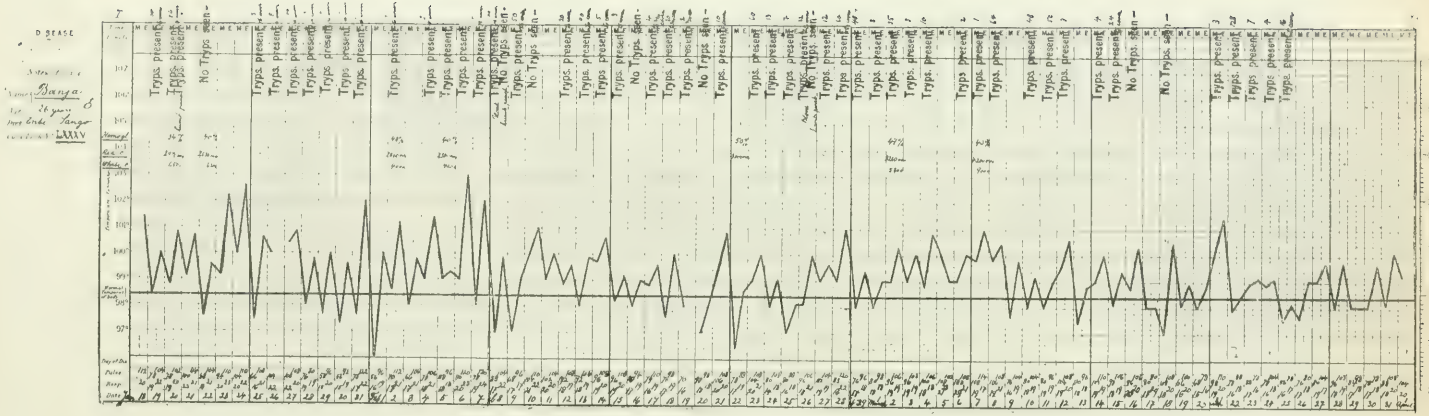
Case 85. Banja. Male. Age twenty-six.

History.—Patient comes from the Sango district of the Bangala country, where Congo Sickness, so far as we know, is not present. He has been employed for some years on steamers plying on the upper river. A month before being sent to hospital was imprisoned on a charge of cannibalism. No history of illness before going to prison.

January 20, 1904. General condition: Somewhat emaciated; expression pained and anxious; intelligence fair, answers questions slowly but correctly; breathing laboured—is apparently very ill. His skin is dry and filthy, no 'craw-craw.' Slight oedema of forehead, considerable of shins and feet; lymphatic glands all enlarged, especially femoral and inguinal; tongue coated, moist, and steady.

Circulatory system, heart sounds booming at apex; pulmonary second sound accentuated and dicrotic. Respiratory system, dullness at base of right lung, loss of breath sounds, pleuritic rub and moist rales. Liver enlarged and painful. Spleen not enlarged. Nervous system, patellar and cremasteric reflexes not obtainable, epigastric increased; pupils equal and react to light.

CASE LXXXV



February 2. Is in better condition, and is brighter than when admitted; abdomen distended; oedema of loins marked.

February 16. Shows no signs of sleep, walks now without any unsteadiness. Appetite large.

February 24. Seems quite well; slight oedema of shins, but none elsewhere; no puffiness of face; can walk about with ease.

March 18. Gait normal, expression contented, no dulness, is quite intelligent, answers questions quickly and well; glands all enlarged, but femorals and inguinals apparently smaller than when admitted to hospital; slight oedema of shins; liver still enlarged, but not tender; heart and lungs, normal; knee jerks, normal; epigastric and cremasteric reflexes obtainable; appetite good; no drowsiness; patient works willingly around the hospital.

April 1. Has certainly put on flesh lately and increased in general robustness.

Symptoms Associated with the Presence of the Parasites in the Blood

The only patient in whom a large increase of parasites was associated with a rise in temperature and the presence of symptoms which might be attributed to the parasite was Mokoko (Case 65), whose case is given above.

From our observations we cannot make out any definite relation between the temperature and pulse and the appearance of the parasites in the peripheral circulation. A rise of temperature is not necessarily associated with an increase of parasites in the blood.

It appears, therefore, that the number or constant presence of the parasites in the peripheral blood bears no relation to the severity of the disease.

Occurrence of Parasites in Serous Fluids

On two occasions 10 c.cm. of fluid was drawn from a flabby hydrocele (in Case 104) and centrifugalized. Parasites were seen each time, although they were absent from the blood to ordinary examination, and probably had been absent for some days previous to the second tapping. The cerebro-spinal fluid of this case was also examined on the same date as the first tapping, but no parasites were seen, although the deposit of the centrifugalized hydrocele fluid showed fourteen to a cover. In another case (number 92), in which the penis and scrotum were very oedematous and there was a small right hydrocele, no parasites were seen in either oedema or hydrocele fluids, although the blood showed thirty to a cover. We have not found parasites in the urine (centrifugalized) in the few cases examined in which the blood showed many parasites.

The Occurrence of the Parasites in Tissues and Fluids after Death

Our examination of film preparations of tissues and fluids taken at autopsies are not completed, but it is interesting to note here the frequency with which the parasites have been seen in the pericardial, pleural, and peritoneal fluids when examined fresh. In three cases (62, see chart, 64, 76) parasites were seen, without centrifugalizing, in the pericardial or peritoneal fluid; one-and-a-half, two, two-and-a-half hours, respectively, after death. In two of these cases numerous longitudinal divisional forms were seen in the pericardial fluid. In three other cases actively motile trypanosomes were seen in the pericardial fluid after centrifugalizing, fourteen, fifteen-and-a-half, twenty-and-a-half hours after death. In all these cases parasites were seen either the day before or a few days previous to death. In only one case has a trypanosome been seen in fluid from a lymphatic gland (omental); but in this case parasites were easily detected in the blood, *post-mortem*, and were very numerous in the pericardial and peritoneal fluids.

Occurrence of Parasites in the Cerebro-Spinal Fluid

During the stay of the expedition at Leopoldville, lumbar puncture was performed on forty-nine natives coming from many parts of the Upper and Lower Congo. Of these thirty-eight were proved to be suffering from trypanosomiasis, the parasites being found in the blood. In the remaining eleven cases no trypanosomes were seen in either the blood or cerebro-spinal fluid, and in some of them a diagnosis of some other disease, *e.g.*, tubercle, dysentery, etc., was established either during life or *post-mortem*.

In twenty-five of the thirty-eight trypanosomiasis cases the parasites were found in the cerebro-spinal fluid, but in thirteen no parasites were seen, although in one case (No. 101) the fluid was examined on five occasions.

If, however, those punctures in which the cerebro-spinal fluid was mixed with the blood in greater proportion than from three to four red cells to a field (Zeiss 1/6 objective, No. 4 eye-piece, diaphragm removed), and in which the parasites were found by coverslip examination to be present in the peripheral blood on the same day as the puncture, be excluded, then we find that the above result is very different, namely, thirty-two cases, in sixteen of which the parasites were found in the cerebro-spinal fluid, and in sixteen they were not. The amount of cerebro-spinal fluid drawn off and centrifugalized at each operation varied from 10 to 30 or even 40 c.cm. This, if necessary, was not only centrifugalized a second or third time, but from one to six coverslip preparations of the resulting deposit were examined before a negative result was recorded.

If the cerebro-spinal fluid is mixed with blood it has a slight yellowish tinge, and is opalescent or clouded according to the amount of blood it contains. If

normal cellular elements are much increased the fluid has also an opalescent or cloudy appearance, but there is no yellowish tinge. It is doubtful whether the presence of the parasite in the cerebro-spinal fluid has any influence upon the increase of its cellular elements. It would seem, from a study of our cases, that the fluid as a rule, whether the parasites be present or not, is perfectly clear and limpid as in health. Only in a few instances, in both positive and negative cases, have the cellular elements shown an apparent increase, consisting mainly of small mononuclear cells, together with some mononuclear large cells. In Case 93, the only one in which a large number of parasites—fifty to a cover—were found in the cerebro-spinal fluid, a great increase of small mononuclear cells was noted at the same time. A month later the cerebro-spinal fluid was again examined, but only one parasite could be found, and the cellular elements were scanty. This case, up to the present date, nearly two months after the discovery of large numbers of trypanosomes in the cerebro-spinal fluid, has shown no tendency to sleep during the daytime, no wasting, nor any of the more noticeable symptoms associated with the later stages of many of our cases of trypanosomiasis.

As a rule, we have found that the parasites occur in extremely scanty numbers in the cerebro-spinal fluid, seldom more than one to three or four, very occasionally from ten to twenty to the cover-glass preparation of the sediment left after centrifugalizing.

As already stated, neither at Leopoldville, nor anywhere on the Lower Congo, up to the present time, have we met with a case of Congo sickness in which sleep has had a prominent place among the clinical symptoms, and in those few cases in which it has been noted a few days before death, or at irregular intervals during the course of the disease, it has not been describable as deep or continuous sleep, but merely a drowsy or somnolent condition from which the patient was at once aroused by being touched or, perhaps, by being spoken to. On comparing the cases in which parasites were found in cerebro-spinal fluid with those in which they were not found, we see that most of the few cases in which drowsiness was a feature, together with cases in which head symptoms, *e.g.*, mild mania, epileptic attacks, flexure contractions, and convulsive seizures, were conspicuous are upon the positive side. On the negative side similar cases are also found, but it is noticeable that there are many of those cases which showed hardly any symptoms, and which, if no fatal complications intervened, lived on month after month in an advanced state of emaciation, retaining their faculties, speech, appetite, etc., almost to the moment of their death.

It is, therefore, not improbable that the presence of the parasites in the cerebro-spinal fluid at a late stage in the disease may tend to increase the gravity of the case by predisposing to one or other of many complications, or, in other ways, hasten a fatal termination ; but that this is not invariably so is proved by at least two of our cases, one of which (Case 93) is now one of the most sturdy patients under observation.

Animal Experiments

We have infected rats, mice, guinea-pigs, rabbits, and monkeys with human trypanosomes taken from cases of Congo Sleeping Sickness, both in its early and its latest phases. As was stated in our first Progress Report the course of the infection in these animals has given us no reason to suppose that we are dealing with more than one species of trypanosomes, or that the parasite is other than *Trypanosoma gambiense*.

All our inoculations have been made with small or medium doses (1 to 5 c.cm.) of infective material, either cerebro-spinal fluid or blood—diluted or no—in which, in almost every case, living trypanosomes, sometimes in enormous numbers, were demonstrated. About 50 per cent. of such inoculations have failed to infect. These failures seem to bear no relation either to the source of the material inoculated, to the site of inoculation—subcutaneous or intraperitoneal—or to the approximate number of parasites injected.

Once more, no animals inoculated with material in which trypanosomes were seen, taken *post-mortem* from cases of trypanosomiasis, have ever become infected. Parasites have been seen in the peripheral blood of infected animals only at more or less irregular intervals. Guinea-pigs have, perhaps, shown themselves the most satisfactory of ordinary laboratory animals, since, as a rule, when once infected, parasites are constantly present in large numbers.

Death, in the small number of our infected animals which have died, can in no instance be certainly said to have been due to the trypanosome alone. These are all points in which the Congo trypanosome resembles *Trypanosoma gambiense*. In addition, the 'incubation period,' that is, the period intervening between the inoculation of small or medium doses of infective material and the detection of the parasite in the peripheral blood of the experimental animal, is much the same for both parasites.

	Cong. trypanosome	Trypanosoma gambiense
Rats	5—20	7—20
Mice	5—16	6—7
Rabbits	17—27	21
Guinea-pigs ...	11—25	12—21

Monkeys of two different varieties, both belonging to the sub-family *Cercopithecus*, have been infected. Only one has shown slight symptoms of ill-health. On two

occasions a slight rise of temperature and loss of vivacity has accompanied one of the irregularly appearing intervals during which parasites have been seen in the peripheral blood. This monkey has been infected for nearly three months.

We have again failed, even with large doses of blood containing huge numbers of trypanosomes, to infect two dog-face monkeys (*Cynocephalus*).

Transmission Experiments

We have attempted to repeat the transmission experiments made by Bruce, in Uganda, with the tse-tse fly. These flies are rather numerous in the bush along the river banks on either side of Leopoldville, and a fair number are daily brought to the laboratory by a gang of boys supplied for the purpose by the local authorities. Practically all the flies brought in by them have been *Glossina palpalis* (native name, 'mavekwa'). Unfortunately, we have had the greatest difficulty in obtaining monkeys and have only been able to use two for these experiments. Both in the Congo and in the Gambia, experiments have shown that the guinea-pig is, perhaps, the laboratory animal most susceptible to *Trypanosoma gambiense*. We, therefore, determined to employ it, lacking monkeys, in our transmission experiments. At the time of writing both experiments with monkeys remain unsuccessful, and only one, a direct transmission experiment with guinea-pigs, in which the flies were made to feed alternately on an infected and an uninfected animal, has given a positive result.

In conclusion, we wish to thank Dr. Inge Heiberg, who has been attached to the expedition by the Government of the Congo Free State, for his untiring kindness and the help he has given us in our work.

Female (Case LXXIX). Illustrating an early stage with general absence of symptoms except rise of temperature.

Two cases from Cataract Region of Congo, showing practically no symptoms. Carried heavy loads for many days without complaint.

Trypanosomiasis cases in the hospital for blacks at Leopoldville, Upper Congo, waiting for their daily ration of 'Kwanga' (Casava bread) to be served out to them.

Kavirondo (Case CII). Main symptoms severe pain and continued headache. No sleep.

Baganda Man (Case XCI). Showing pallid [illegible] drowsy dull expression. Taken six weeks before death.

Oparanga (Case CI). Showing extreme emaciation. Taken three days before death.

To follow page 45

THE CONGO FLOOR MAGGOT

THE CONGO FLOOR MAGGOT

A BLOOD-SUCKING DIPTEROUS LARVA FOUND IN THE CONGO FREE STATE

(*The First Interim Report of the Expedition of the Liverpool School of Tropical Medicine to the Congo*, 1903. *Received January*, 1904)

BY

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IN correspondence, during our stay at Boma, with the Rev. Holman Bentley and Mr. Sutton Smith, both of the Baptist Missionary Society Corporation, we learned of the existence in the Lower Congo of what were called 'floor maggots,' which they described as 'keen blood-suckers.'

It was not, however, until camped at a place called Nkanga, on our way from Tumba to Lutete, in the cataract region of the Congo, that we had an opportunity of seeing specimens of these maggots. Here, the head man of a neighbouring village, after being questioned on the subject of native pests, collected for us during the night, a number of what appeared to us –at first sight—to be ordinary blow-fly maggots. On a closer inspection many of them were seen to contain bright red blood.

A day or two afterwards, when visiting a native village, we had the opportunity of seeing the natives collect these blood-suckers by digging with the point of a knife or scraping with a sharpened stick in the dust-filled cracks and crevices of the mud floors of their huts. We were soon able to find them ourselves as easily as the natives, and unearthed many larvae which contained bright red blood. In collecting them the natives selected those huts in which the occupants slept on floor mats, saying that where people slept on beds or raised platforms the maggots were not so numerous. They informed us, however, that those who slept in beds which were not raised more than eighteen inches from the ground were also bitten, and credited the maggot with the power of jumping to that height. In some of the huts we collected, in a short space of time, as many as twenty from only a small proportion of the floor crevices. Many were turned up from a depth of three inches. In some of the cracks, and in moist, soft earth, they were found at greater depths. There is

no doubt that these maggots feed only at night. Mr. Bentley told us that as many as fifty could sometimes be found beneath a single mattress, and that he had known boys to be so pestered by them that they had preferred to sit all night outside a house to sleeping within it.

In one village, Nzungu, we visited a hut, measuring eight feet by ten feet, in which seven boys were sleeping on a small mat, and in the dust beneath a bed-platform on which slept a man and a woman. In the corner of the hut was the usual small fire and a sleeping pye-dog. Although we did not see the maggots actually feeding, we collected from beneath the mats and from amongst the boys' legs some half-dozen which were filled with recently sucked blood. The natives said that the maggots dropped off at once if the limb on which they were feeding was moved. There were specimens of all sizes, ranging in length from 2 to 15 mm. amongst those brought to us, and so far we have obtained them in every village we have visited. When ready to pupate, the larva lies dormant upon the surface, changes in colour to a pinky-brown, and later becomes a dark-reddish or brownish-black, chitinous, segmented, and oblong puparium.

We have never been able to substantiate the assertion, made to us on several occasions, that the maggot is able to jump to a height of eighteen inches. We think it more probable that they reach the raised beds by crawling up either the supports or the grass wall against which the bed is usually placed. We have, however, satisfied ourselves that it feeds mainly or entirely at night, and that it probably feeds nightly since blood in varying stages of digestion, and ranging in colour from bright red to black, can often be seen in its alimentary canal.

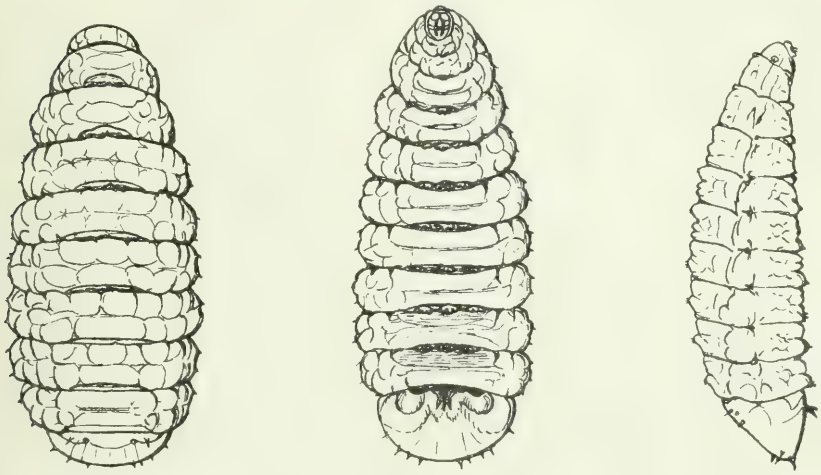
The distribution of this larva seems to be very extensive. We have collected it all over the Lutete and surrounding districts, and at Leopoldville. We have heard of it as being common at San Salvador, in Portuguese territory, on the Congo at Matadi in the cataract region, and at Tchumbiri one hundred and fifty miles above Stanley Pool.

Some of the native names for the maggot are as follows :—

At Tchumbiri, north of Leopoldville, the Bateke, according to Mrs. E. Billington of the Royal British Nurses' Association, call it 'Mabinzu.' At Leopoldville the Bateke call it 'Nchichi.' At Wathen (Lutete), in the cataract region, Mr. Bentley states that all maggots are called 'Ntunga,' and that there was no other special name for this one. At Matadi the native name is probably 'Mvidi.' In the Bangala district it is called 'Kiso.'

This larva maggot is semitranslucent, of a dirty white colour, acephalous, and amphipneustic. It resembles, when adult, the larvae of the bot-flies, and consists of eleven very distinct segments. The first or anterior one is divisible, by a slight constriction, into two portions, the foremost of which is small, bears the mouth parts, and is capable of protrusion and retraction to a considerable extent.

The larva is broadest at the ninth and tenth segments, is roughly ovoid in transverse section, and has, distinctly, dorsal and ventral surfaces. At the junction of the two surfaces is a row of irregular protuberances, two or more being placed on each segment. On each protuberance is a small posteriorly directed spine and a small pit. The central part of the ventral surface is flattened, and at the posterior margin of each segment is a set of three foot-pads, transversely arranged, each covered with small spines directed backwards. These aid the larva in its movements, which are fairly rapid and peculiar in that the mouth parts are protruded to the utmost and the tentacula fixed, as a purchase, first on one side then on the other, while a wave of contraction runs along the body as each segment is contracted and brought forward.



Dorsal Surface Ventral Surface Lateral Surface

Congo Ficor Maggot (× 4·5)

The last segment is larger than any of the others. Its upper surface is flattened, and looks backwards and upwards at an angle of about forty-five degrees with the longitudinal axis of the larva. This surface is roughly hexagonal and bears anteriorly, one on either side, the posterior spiracles which are seen with a pocket magnifying glass as three transverse, parallel, brown lines. Around this flattened surface, towards its border, are placed groups of rather prominent spines. The ventral surface of this segment is also flattened, and is thrown into folds by muscular contractions. The anus is situated in the anterior portion of this segment in the middle line, and is seen as a longitudinal slit, surrounded by a low ridge. Posterior to it, and on either side, is a large conspicuous spine. The anterior segment is roughly conical, and bears the mouth parts in front. Posteriorly, on the dorsal

surface, almost covered by the second segment, two spiracles, on either side, are seen with a low power as small brown spots. Two black hooks or tentacula protrude from the apex of this segment. They are curved towards the ventral surface of the maggot. The apex of each hook is blunt, and its base surrounded by a fleshy ring. Between them is the oral orifice. The tentacular processes are continued for some distance into the body of the maggot as black chitinous structures with expanded bases. There is probably, as in *Oestrus ovis* (Linn.), an articulation between the external and internal chitinous structures, since the arrangement of the mouth parts seems to be the same as in the maggot of that fly. Paired groups of minute spicular teeth are placed around the two tentacula so as to form a sort of cupping instrument. The arrangement of these teeth is as follows :—A rather large tubercle is situated on either side of and above the tentacula ; each is mounted by two or more groups of very small chitinous teeth. Just above each tentaculum is another small group of teeth. On either side of these black tentacula two irregular rows of small teeth are placed one above the other. The two latter groups are not placed upon tubercles. The integument of the larva is thick and difficult to tear. The larva is able to withstand a good deal of pressure without injury.

The following gross internal anatomical structures have at present been made out—intestinal canal, salivary gland, nervous system, and fat body. The intestinal canal commences as a short oesophagus, which ends in a proventriculus. A remarkable dorsal diverticulum, corresponding to the food reservoir of the muscid larvae, opens into the oesophagus near its anterior end. After the maggot has fed, the diverticulum is a very conspicuous object, since it is seen through the semi-transparent body wall as a bright red area when full of blood, extending from the head to about the fifth segment. The caeca, behind the proventriculus, have not as yet been well made out. The mid-intestine or chyle stomach is short, when compared with the hind intestine, and extends from the proventriculus to the junction of the urinary tubules with the gut. It lies in one or two coils. The hind intestine is very much coiled, and occupies the greatest part of the body cavity.

The urinary tubules are four in number, two on either side of the intestine. Each lateral pair combines to form a broad plate, from which is given off a single process for attachment to the gut.

Each salivary gland of the larvae consists of one very long acinus made up of large granular cells. The gland ends in a chitinous ringed duct, which joins its fellow of the opposite side to form a common duct, opening near the base of the free portion of the tentacula. The body of the maggot is lined by a white, loosely reticulated fat body. The minute anatomy of the mouth parts and sucking apparatus has not been studied.

The time required for the maturation of the larva is not yet known. The puparium is a dark-brown or black, cylindrical, segmented body, measuring 9-10·5 mm.

in length and 4–5 mm. in width. The anterior end is roughly conical, the posterior is rounded. All the external structures seen in the larva can be made out on the external surface of the puparium. The cuticle shows annular ridges.

The duration of the puparial stage is from a fortnight to three weeks.

During our stay at Wathen, Mr. Bentley showed us, among his collection of insects, a large light-brown fly which he believed to be developed from the floor maggots. Specimens caught in the boys' dormitory at the Wathen Mission were soon after brought in by one of our collectors, and later, while searching a native hut infested with 'floor maggots,' we saw one of these flies resting on the grass wall. Many others were subsequently found in the same building, sitting motionless amongst the beams and cob-webs of walls and roof. Because of their colour, which corresponded exactly with the smoke-stained straw and rafters of the huts, they were difficult to see, and in the dark interiors more difficult to catch.

This fly, seldom one of any other species, has since been found in many huts infested with maggots. We were told that the fly deposited its eggs on the ground of a hut, particularly in spots where urine had been voided. As a rule the fly is silent, but on one occasion we observed it buzzing loudly, fly in at the door and go directly beneath some bed mats which were raised by a low platform, some eight centimetres from the floor.

Both Mr. Bentley and the natives state that this fly never bites men.

The native name at Wathen for all flies is 'Nwanzi' or 'Mbwanzi.' The name for the fly which we describe is 'Nkulu Mwanzi.' The fly is thick set, and is of about the size and build of a 'blue bottle.' It is about 10–12 mm. in length, and once seen can be easily recognized. Its general colouring is tawny, but the small black hairs covering its body give it a smoky appearance. The head is large, as broad as the thorax, and protrudes in front of the eyes, which are when fresh a reddish brown in colour. The eyes are separated from each other, below, by a considerable interval and appear small in comparison with the size of the head. The proboscis is folded beneath the head in a deep groove, and is inconspicuous while in this position.

The palpi are club-shaped and covered, more particularly at their apices, with conspicuous black bristles. The third joint of the antenna is long, yellow, flattened from side to side, and rounded at its apex. It bears an arista which, thickened at its base (probably jointed), tapers to a fine point. The arista bears fine black hairs along its upper and lower borders; long at its base, the hairs become short and slanting at its apex. The dorsum of the thorax is flattened, and marked by longitudinal black and brown stripes, the transverse suture is well marked. The thorax is covered with fine black hairs and studded with rows of black bristles, which are particularly long on the sides. The squamae are very large, yellow in colour, and completely cover the yellowish-white halteres. The abdomen apparently consists of five segments. It is covered with long black hairs, and bears a few long bristles

on the last two segments. The second segment is the longest, and here the width of the abdomen is greatest, the upper surface of this segment is characteristically marked. A dark-brown or black line runs down the centre of the segment to meet at right angles a similar line which borders its posterior edge. There are no other marks on this segment, it is transparent, and its general colour is that of the rest of the body. The third segment is, except for a narrow yellow streak along its anterior border, very dark brown in colour, more marked laterally. The fourth segment is of the same dark colour, and is bordered posteriorly by a narrow lighter brown band. The fifth segment is small, and contains the genital apparatus. The wings are of a smoky brown colour, and show a well-marked venation. The legs are of the same buff as the rest of the body, and are covered with black hair and bristles. A noticeable feature of the legs is the jet-black fifth tarsal joint, which stands out prominently against the large cream-white pulvilus.

We have been able to allow a number of these maggots to feed on rats and guinea-pigs. We purpose carrying out a series of experiments with the object of determining whether they are able to play a part in the transmission of the human trypanosome. In none of the entomological works, which we can at present command, are we able to find any reference to habits or morphology by which we can identify this fly.

Specimens of the flies and larvae were submitted for identification to Mr. E. E. Austen, the dipterologist to the British Museum, together with a copy of the above report, and he has been kind enough to write as follows :—'I have read the report on the "Blood-Sucking Floor Maggot" with the greatest possible interest. Whether this maggot prove to be in any way concerned in the dissemination of trypanosomiasis or no, Messrs. Dutton, Todd, and Christy have come across an entirely novel and most interesting fact in the biology of diptera, and they are heartily to be congratulated on being the first to bring it to notice.

The flies are specimens of *Auchmeromyia luteola*, Fabr. (a species of the family Muscidae), which is widely distributed in tropical and subtropical Africa. Before reading the report, I was under the impression that the larvae of this fly were well known subcutaneous parasites of human beings and dogs, but I have now no doubt that *A. luteola* has been confused with another fly, very similar to it in appearance, but belonging to a different genus, the larvae of which are unquestionably subcutaneous parasites in man, dogs, and monkeys. Nevertheless,' says Mr. Austen, 'I have evidence, apparently reliable, which seems to show that the larvae of *A. luteola* may, perhaps, under exceptional circumstances, live subcutaneously in man. The fly itself, so far as I am aware, is otherwise harmless, and is incapable of sucking blood. Specimens in the national collection show that it ranges from Northern Nigeria to Natal ; it is therefore somewhat surprising that the habits of the larva have not been reported before.'

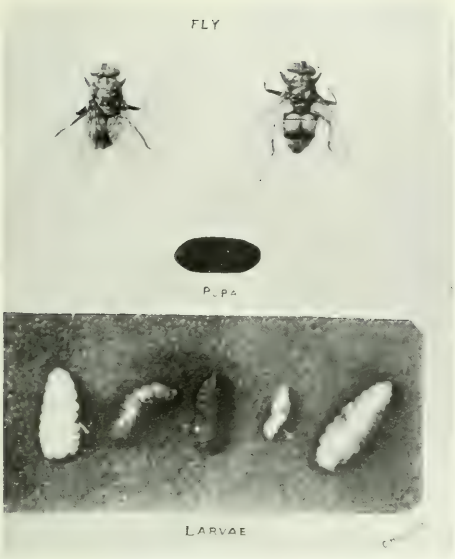


Fig. 1

Fig. 2

Fig. 3

CONGO FLOOR MAGGOT AND FLY

Fig. 1. Flies, pupa and larvae (nat. size). Fig. 2. Markings in the sand, produced by larvae.
Fig 3. Larvae immediately after, and some hours after, feeding. (× twice).

THE CEREBRO-SPINAL FLUID IN SLEEPING SICKNESS (TRYPANOSOMIASIS)

THE CEREBRO-SPINAL FLUID IN SLEEPING SICKNESS (TRYPANOSOMIASIS)

104 LUMBAR PUNCTURES

Second Interim Report of the Expedition of the Liverpool School of Tropical Medicine to the Congo, 1903

BY

CUTHBERT CHRISTY, M.B., C.M., EDIN.

THE majority of the punctures recorded in the accompanying tables were performed whilst working with Drs. J. E. DUTTON and J. L. TODD, in the Congo Free State. All, with the exception of three, were performed by myself either at Boma, Leopoldville, posts further up the Congo, or since returning to England. Some conclusions drawn from a number of them are published in our last conjoint report.[1]

Out of a total of sixty-four natives operated upon, the fifty-four in Table I were proved to be cases of sleeping sickness by the discovery of trypanosomes in the blood or cerebro-spinal fluid, or in hydrocele fluid ; while in the remaining ten in Table II, parasites were never found, although the majority of them were more or less suspicious cases, and all were in hospital at Leopoldville.

In thirty-four of the fifty-four sleeping sickness cases the parasites were found sooner or later in the cerebro-spinal fluid, whereas in twenty of them no parasites could be found, although in one (Case 17) the fluid was examined on five occasions.

If, however, those punctures in which the cerebro-spinal fluid was mixed with blood, and in which the parasites were found by coverslip examination to be present in the peripheral circulation on the same day as the puncture, be excluded, then we find that the result is very different, namely, forty-nine cases only, in twenty-five of which trypanosomes were found in the cerebro-spinal fluid, and twenty-four in which they were not found.

A reference to Cases 19, 20, 21, will show how important it is to exclude from all statistics those punctures in which the fluid contains trypanosomes with blood cells when the parasites are known to be in the blood stream. Cases 20 and 21 show clearly that when the fluid is mixed with blood the number of parasites appearing in it is closely in proportion, not only to the number in the blood, but to the amount of blood admitted by unskilful puncture. I therefore in this analysis will exclude from consideration all punctures in which the cerebro-spinal fluid and the blood both show trypanosomes when blood is admitted into the fluid. In the Tables these are marked with an asterisk in the name column.

1. *Second Report*, p. 1.

TABLE I. SLEEPING SICKNESS CASES

Indicates trypanosomes present. Indicates trypanosomes absent. C.Cm., and L.F. each continuously.

The cases recorded in this table include those only which have appeared in the C.S.I. when trypanosomes are known to be present in the blood.

No.	Name		Date	Sex	Age	Trypanosomes in Finger Blood	CEREBRO-SPINAL FLUID: C.Cm. examined	Days ill before death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	Remarks on Duration, Course, Progress, Symptoms, etc., and Mode of Death
1	[illegible]		1-12-03	♂	3	1 cover, 1 examined	18	11	4 covers examined.	Clear		None	28-12-03	Duration about [illegible] months. [illegible] symptoms of sleep. Complete [illegible] punctured. Complete [illegible]
2	Lasasi	*	16-12-03	♂	20	1 5 to cover.	1	—	1 7 to cover.	Cloudy.	..	Many	16-12-03	Always slightly drowsy, increased before death.
3	Salumo	*1	18-12-03	♀	24	1 3 to cover.	15	2	+ 4 to cover.	Slightly cloudy.	Increased.	A few	2-1-04	Duration about three months. Sudden acute dozing [illegible] days before death. Many division forms of trypanosoma in C.S.F., pericardial fluid, and bone marrow one and a half hours *P. M.*
		2	2-01-04			1 13 to cover.	40	*P. M.*	+ many.	Cloudy.	Increased.	None.	..	
4	Mokoko ..	*	19-12-03	♂	21	1	17	..	+ 3 to cover.	Cloudy.	Increased	Many.	..	Few symptoms. After being two months in hospital was discharged by medical officer as fit for duty. On January 5 his blood showed [illegible] trypanosomes to the cover.
5	Dyatki .		19-12-03	♀	26	2 covers examined	18	2	+ 1 in 4 covers.	Clear	Increased.	A few.	21-12-03	Emaciation but no sleep symptoms till day before death.
6	Bambiki		19-12-03	♂	16	2 covers.	6	6	1st centrif. 3 covers.	.	.	.	..	Extreme emaciation, slept a good deal, and was semi-comatose for three days before death. Bed-sores.
									2nd centrif. 3 to cover.	Cloudy.	Scanty.	Many.	25-12-03	
7	Polulu ..	*1	21-12-03	♂	23	1 1 in 2 covers.	2	21	+ 1 in 2 covers.	Cloudy.	Scanty.	Many.	..	December 19 had severe left hemiplegic seizure. No sleep symptoms at any time. *P. M.* Extensive purulent meningitis. Cysticercus in trapezius.
		2	31-12-03			1 3 to cover.		11	1st centrif. 2 covers.	Slightly cloudy.	Scanty.	None.	11-1-04	
									2nd centrif.					
8	Tenda	1	23-12-03	♂	30	2 covers.	30	103	4 covers. 2 centrif.	Clear and limpid	Very scanty.	None	..	Duration about five months. Progressive emaciation. Frequently found dozing during January, but subsequently marked absence of nearly all symptoms. Retained faculties and was able to walk till hour of death. Pericranial and peritoneal fluids both showed active division forms twenty-and-a-half hours after death.
		*2	16-1-04			1 6 to cover.	3	79	+ 1 in 2 covers	Cloudy.	Increased.	A few.	..	
		3	27-2-04			2 covers.	25	37	4 covers. 2 centrif.	Clear and limpid.	Very scanty.	None.	..	
		4	31-3-04			2 covers.	16	4	+ 1 in 2 covers	Clear.	Scanty.	A few.	4-4-04	
		5	5-4-04			2 covers before death.	47	*P.-M.*	5 covers. 13 hours *P. M.*	Slightly cloudy.	Increased.	None.	..	

TABLE I.—*Continued*

No.	Name		Date	Sex	Age	Trypanosomes in Finger Blood	Cerebro-Spinal Fluid: C.Cms. drawn off	Days before death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	Remarks on Duration of Case, Prominence of Sleep, or other Symptoms, etc., and Mode of Death
9	Monteka ..	1	24-12-03	♂	19	−	3	21	− 4 covers.	Clear.	Scanty.	A few.	..	Duration about three months. Rapid emaciation. Irritable and troublesome. Helpless, dazed, semi-comatose condition for two days before death.
		2	8-1-04			+	16	9	+	Clear and limpid.	Scanty.	None.	14-1-04	
10	Manga ..	*	26-12-03	♂	22	+	30	9	+	Slightly cloudy.	Increased.	A few.	4-1-04	Duration about five months. Marked absence of symptoms till ten days before death when sudden fit, followed by semi-comatose condition, great salivation, abolished reflexes, and erection of penis. Improved somewhat before death.
11	Kalenga .	*1	26-12-03	♂	24	+ 1 in 2 covers.	18	45	+ 2 to cover.	Cloudy.	Scanty.	Many.	9-2-04	Marked sleep symptoms, no emaciation. Death due to sun exposure, temperature 107°. Blood showed trypanosomes to cover five minutes before death.
		2	9-2-04			2 covers 1½ hours *P.M.*	24	*P.M.* 1½ hrs	− 4 covers. 2 centrif.	Cloudy.	Much increased.	None.	.	
12	Maradina ..	*1	29-12-03	♂	18	+ 2 to cover.	14	28	+ 36 to cover.	Cloudy.	Scanty.	Many.	..	Duration about four months. Had epileptic attacks, few sleep symptoms, simple minded condition. Six days before death, tremors of limbs, opisthotonos and semi-coma. *P.M.* Pneumonia and purulent meningitis.
		2	22-1-04			2 covers.	18	4	3 covers. 2 centrif.	Clear and limpid.	Scanty.	None.	26-1-04	
13	Kabidi .	1	29-12-03	♀	27	− 2 covers.	5	..	8 covers. 2 centrif.	Cloudy.	Increased.	A few.	.	Duration about five months. Progressive weakness, drowsiness, and emaciation from the first. No marked nervous symptoms. Died suren.
		2	2-2-04			+ ½ to cover.	32	17	5 covers. 2 centrif.	Clear.	Scanty.	A few.	.	
		3	7-3-04			− 2 covers.	15	1	5 covers. 2 centrif.	Clear.	Scanty.	None.	8-3-04	
14	Molamba	1	7-1-04	♂	32	2 covers.	14	..	5 covers. 2 centrif.	Cloudy.	Increased.	Many.	..	No marked symptoms, no drowsiness or dullness. Recurring attacks of dysentery.
		2	5-2-04			1 in 2 covers.	22	..	3 covers. 2 centrif.	Clear and limpid.	Scanty.	None.	..	
15	Kondolo ..	1	8-1-04	♂	32	− 2 covers.	20	80	5 covers. 3 centrif.	Clear and limpid.	Very scanty	None.	..	Three months in hospital. Marked absence of symptoms except headache. Ten days before death headache severe. Suicide by drowning.
		2	14-3-04			− 2 covers.	22	14	2 covers. 2 centrif.	Clear and limpid.	Very scanty.	None.	28-3-04	
16	Fjoli		7-1-04	♂	28	2 covers.	8	19	− 3 covers 3 centrif.	Clear.	Increased.	None.	..	Drowsiness. Great emaciation. Few symptoms. Conscious till hour of death.

TABLE I. *Continued*

No.	Name		Date	Sex	Age	Trypanosomes in Finger Blood	CEREBRO-SPINAL FLUID: C.Cms drawn off	Days before death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	Remarks on Duration of Case, Prominence of Symptoms, etc., and Mode of Death.
17	Opanga ..	1	7-1-04	♂	18	2 covers.	16	62	3 covers. 2 centrif.	Clear and limp.	Scanty.	None.	..	Duration five or six months. Progressive weakness and emaciation from the beginning. Extreme emaciation at death. No dulness or marked symptom of any kind, except drowsiness during January, but less subsequently. Could walk, and retained faculties till hour of death. Trypanosomes in blood scanty and seldom seen.
		2	27-1-04			+ 3 to cover.	2	42	7 covers 3 centrif.	Clear and limp.	Scanty.	A few.	.	
		3	11-2-04			2 covers.	2	27	2 covers. 2 centrif.	Clear and limp.	Scanty.	None.	..	
		4	23-2-04			- 2 covers.	14	15	- 3 covers. 2 centrif.	Clear and limp.	Scanty.	None.	..	
		5	2-3-04			+ 48 to cover.	10	7	- 6 covers. 2 centrif.	Clear and limp.	Scanty.	None.	9-3-04	
18	Kimfuta ..	..	15-1-04	♀	9	+ 8 to cover.	16	5	+ many.	Clear and limp.	Very scanty	None.	20-1-04	Duration about two months only. Rapid emaciation, weakness, tremors, and vacancy. Sleep symptoms only present towards the end.
19	Baija	*1	24-1-04	♂	26	+ 80 to cover.	8	..	+ many.	..	..	Much blood	..	Was admitted January 5 from prison, chained to two other prisoners, and charged with cannibalism. Emaciation due to starvation. By end of February quite well and putting on flesh. At end of April started for England, arriving apparently in robust health. Now fat and well, and is employed in Johnston Laboratory, Liverpool.
		2	8-2-04			+ 100 to cover.	50	..	- 4 covers. 2 centrif.	Clear and limp	Scanty	None.	..	
		3	26-2-04			+ 32 to cover.	20	..	4 covers. 2 centrif.	Clear and limp.	Scanty.	None.	..	
20	Ieri	1	20-1-04	♂	11	+ 2 to cover.	20	19	+ 1 in 2 covers.	Clear and limp.	Very scanty	None.	..	Duration about four months. Progressive weakening and wasting interrupted by periods of partial recovery. Somnolence marked towards the close. Appetite voracious to within three days of death. Marked retraction of head and opisthotonos for several days before death. *P.-M.* No signs of purulent meningitis.
		2	27-1-04			+ 4 to cover.	10	12	+ 4 to cover.	Clear and limp.	Very scanty	None.	..	
		*3	5-2-04			+ 150 to cover.	10	3	+ 40 to cover.	Cloudy.	Scanty.	Many.	..	
		*4	8-2-04			+ 250 to cover.	15	0	+ 1 in 2 cover	Clear.	Scanty.	A few.	8-2-04	
21	Moidi	1	21-1-04	♀	24	- 2 covers.	6	16	- 3 covers. 2 centrif.	Clear.	Scanty.	A few.	..	Duration about three months. Drowsiness a marked symptom latterly. Very little wasting. Sensations much dulled. Lumbar puncture without cocaine.
		*2	25-1-04			+ 13 to cover.	35	12	+ 3 in 4 covers.	Clear.	Scanty.	A few.	..	
		*3	5-2-04			+ 100 to cover.	15	1	+ 20 to cover.	Slightly cloudy.	Scanty.	Many.	6-2-04	
22	Kapinga ..	..	23-1-04	♀	24	+ 1 in 2 covers.	20	12	+ 1 in 3 covers	Slightly cloudy.	Much increased.	None.	4-2-04	No drowsiness at any time. Progressive weakness, vacancy, and emaciation.

TABLE I.—*Continued*

No.	Name	Date	Sex	Age	Trypanosomes in Finger Blood	Cerebro-spinal Fluid: c.cms. drawn off	Days before Death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	Remarks on Duration of Cases, Prominence of Sleep and other Symptoms, etc., and Mode of Death
23	Patesa . .	3-2-04	♀	12	+ thousands, 15 to field.	1·	3	— 6 covers, 2 centrif.	Clear.	Scanty.	A few	3-2-04	Only four days under observation. Admitted for dysentery. Emaciation extreme. No drowsiness or vacancy. L.P. four hours before death. Spleen punctured at same time showed Sc. trypanosomes to field
24	Bayo	9-2-04	♂	19	2 covers.	32	3	+ 3 covers, 2 centrif.	Slightly cloudy.	Increased.	None.	9-2-04	Duration three to four months. L.P. soon after convulsive seizure, with high temperature and unconsciousness, due to sun exposure. Six hours before puncture, finger blood showed Ia. trypanosomes to the cover.
25	Benjamin .	9-2-04	♂	28	+ 2 to cover	13	1	+ 9 to cover	Slightly cloudy.	Greatly increased Lots pus.	None.	10-2-04	Duration about three months. Progressive weakness and emaciation. Seldom drowsy. Hemoss almost amounting to triperis before death, which was hastened by surety posture. P.M. Intense cerebral congestion.
26	Bayo Mitchel 1	11-2-04	♂	16	— 1 cover	15	1&3	+ 3 to cover.	Cloudy	Increased.	Many		Duration about five months. Drowsiness very marked. Extreme emaciation during last month on voyage to England. Died on the way to Liverpool.
	2	27-2-04			— 2 covers	16	9 9	4 covers 2 centrif.	Clear.	Increased.	None		
	3	11-3-04			2 covers	28	8 4	+ 1 to 2nd centrif	Slightly cloudy	Increased.	Many		
	4	24-3-04			+ 5 to cover.	35	1	+ 1 in 5 covers	Clear and limp	Scanty	None.	24-3-04	
	5	24-3-04			1 cover	3	P. M.		Cloudy	Increased	None		
27	Katongo	11-2-04	♂	35	4 to cover	4		4 covers. 2 centrif.	Clear and limp	Scanty	None		Very few symptoms. No drowsiness. Still under observation. On March 24, hydrocele fluid negative, three covers examined, blood positive, 12 to cover.
28	Kikoshi. 1	2-2-04	♂	19	+ 1 to cover	30		+ 6 to cover	Slightly cloudy.	Much increased.	None		Still under observation. Nervous tremors and exaggerated reflexes on admission, but improved subsequently.
	2	25-3-04			— 2 covers.	26	.	+ 1 in 1 cover.	Clear and limp.	Scanty.	None.		
29	Yawai . 1	24-2-04	♀	25	2 covers	42	9	3 covers. 2 centrif.	Slightly cloudy.	Increased	A few.	..	Duration two months only. Rapid progressive weakness and wasting. Symptoms of drowsiness not marked. Extensive bed sores. Conscious till hour of death.
	2	28-2-04			4 covers.	1·	7	1 in 3 covers.	Clear	Increased.	None.	..	
	3	4-3-04			2 covers.	15	—	4 covers	Clear and limp.	Scanty.	None.	4-3-04	

TABLE I.—*Continued*

No.	Name		Date	Sex	Age	Trypanosomes in Proper Blood	Cerebro-spinal Fluid: Centrifuged off	Days before Death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	Remarks on Duration of Cases, Prominence of Symptoms, etc., and Mode of Death
30	Pleku		26-2-04	♂	27	1 cover.	22	9	5 covers.	Clear and limp.	Scanty.	None.	4-3-04	Admitted February 2 for dysentery. No drowsiness. Great emaciation.
31	Bagweeai		2-3-04	♂	16	1 to 48 to cover.	25	19	5 covers, 2 central.	Clear and limp.	Scanty.	None	..	Duration about three months. Irritable, hysterical, and troublesome. March 16, wasting and incoordination of movements. March 20, suddenly fell down in a fit. Then developed incoherent jabbering mania, contracture of arms, with athetoid movements of fingers, and putting at blanket. *P.M.* Lymph found over, ventricles of brain distended, etc.
			21-3-04			2 covers.	15	0	3 covers, 2 central.	Slightly cloudy. Straw colour.	Scanty.	Many	21-3-04	
32	Belambo ..	1	27-2-04	♂	26	4 covers.	24	40	+ 1 to 4 covers.	Cloudy.	Greatly increased.	Many.	..	Duration about three months. Drowsiness at no time very marked, but increasing symptoms, tremors, and increased reflexes from day of admission. On March 13 developed spasmodic flexion of arms with convulsive movements of face and many muscles of body. No wasting. Appetite good, and conscious till hour of death. Reflexes nearly absent at death.
		2	9-3-04			..	18	35	+ 1 in 4 covers.	Clear.	Increased.	None.	..	
		3	3-3-04			2 covers.	20	14	+ 80 to cover.	Cloudy.	Increased.	Many.	..	
		4	13-4-04			2 covers.	40	0	+ 1 in 6 covers.	Clear and limp.	Scanty.	None.	13-4-04	
33	Latah	..	29-2-04	♂	26	- 5 covers.	18	2	+ 3 to cover.	Slightly cloudy.	Greatly increased.	None.	2-3-04	Admitted to hospital as a jabbering lunatic. Not suspected of sleeping sickness. Under observation for two months. Trypanosomes never found in blood. Slept a good deal latterly.
34	Mozao .. .	1	11-3-04	♂	16	+ 3 to cover.	18	-	5 covers, 2 central.	Clear and limp.	Scanty.	None.	..	No very marked symptoms, but extreme emaciation.
		2	18-3-04			2 covers.	4	0	- 3 covers.	Clear.	Increased.	None.	18-3-04	
35	Batanga		14-3-04	♂	27	- 2 covers.	24	24	+ 2 to cover.	Clear.	Slightly increased.	None.	7-4-04	Duration about three months. Marked sleep symptoms. Epileptic attack March 17. At L.P. pressure of fluid considerable. Improvement in symptoms after puncture
36	Bandela ..	1	16-3-04	♂	10	- 2 covers.	22	30	4 covers, 2 central.	Clear.	Increased.	None.	16-4-04	Duration five months. March 12, had appearance of bloated cretin, with marked sleep symptoms, which disappeared for several days after L.P. Salivation, no wasting. *P.M.* Large quantity ventricular and subarachnoid fluid.
		2	16-4-04			- 1 cover from heart.	50	*P.-M.*	3 covers, 8 hours' *P.-M.*	Cloudy.	Much increased	None.	..	

TABLE I.—*Continued*

No.	Name	Date	Sex	Age	Trypanosomes in Finger Blood	Cerebro-Spinal Fluid: C.Cms. drawn off	Cerebro-Spinal Fluid: Days before Death	Cerebro-Spinal Fluid: Trypanosomes	Cerebro-Spinal Fluid: Clear or Cloudy	Cerebro-Spinal Fluid: White Cells	Cerebro-Spinal Fluid: Red Cells	Date of Death	Remarks on Duration of Cases, Prominence of Sleep and other Symptoms, etc., and Mode of Death
37	Mengo	10-3-04	♂	24	− 2 covers.	26	..	+ 6 covers. 2 centrif.	Clear.	Scanty.	A few.	..	Admitted March 2 with very marked nervous symptoms, childish and irritable. One finger with finger on patella caused uncontrollable clonic movements of legs, and a light tap caused violent extension of whole body and legs, so powerful as to throw him off a chair yet able to walk about and do light work. Observations up to April 29, 1904.
	Hydrocele fluid	10-3-04			2 covers.	..	..	+ 14 to cover.	Cloudy.	Large quantity.	None.		
	,, ,,	25-3-04			2 covers.	..	..	+ 2 in bulk deposit.	Cloudy.	Large quantity.	None.		* Refers to hydrocele fluid only.
38	Tumba .. 1	26-3-04	♂	21	2 covers.	35	4	+ 2 to cover.	Slightly cloudy.	Scanty.	Many.	..	Duration about three months. Marked dulness and sleep symptoms. March 22, developed tremors and flexors of arms, which in case died on March 26th. Consciousness up to time of death.
	2	31-3-04			2 covers.	34		4 covers 2 centrif.	Clear and limp.	Scanty.	None.	31-3-04	
39	Molar	26-3-04	♂	14	2 covers.	15	..	+ 2 covers.	Clear.	Scanty.	A few.	.	Mission boy, only under observation for a few days.
40	Mokindi	2-4-04	♂	18	+ 4 to cover.	2		5 covers 2 centrif.	Clear and limp.	Very scanty.	None.	.	An early case. Did not admit that he was sick. Marked dulness, but no sleep. Distension of cells.
41	Nakanyi	4-4-04	♂	17	+ 16 to cover.	18	4	4 covers 2 centrif.	Clear and limp.	Very scanty.	None.	8-4-04	Admitted a month before death for dysentery. Great emaciation and weakness, otherwise few symptoms, and none of sleep.
42	Panta	6-4-04	♂	18	+ 4 to cover.	18		5 covers 2 centrif.	Clear and limp.	Scanty.	None.		An early case. Few marked symptoms and none of sleep.
43	Kitambala ..	7-4-04	♂	13	4 covers.	18	..	4 covers.	Clear and limp.	Scanty.	None.		An early case. Marked dulness, but no sleep.
44	Katumbue	14-4-04	♂	24	2 covers.	26	..	+ 3 to cover.	Slightly cloudy.	Increased.	A few.		An advanced case. Only under observation for one day. Was doing duty up to February 27, 1904.
45	Kabulu	14-4-04	♂	20	+ 2 covers.	24	..	+ 16 to cover.	Slightly cloudy.	Scanty.	A few.	..	An advanced case. Only under observation for one day. Was doing duty up to February 17, 1904.
46	Ekonge ..	18-4-04	♂	21	2 covers.	22	..	+ 6 to cover.	Slightly cloudy.	Increased.	A few.	..	Advanced case seen on the march, and punctured under difficulties in the grass.
47	Mbeka	18-4-04	♂	19	+ 2 to cover.	2	.	− 4 covers 2 centrif.	Clear and limp.	Scanty.	None.	..	An early case, with no symptoms.

TABLE I.—*Continued*

No.	Name	Date	Sex	Age	Trypanosomes in Finger Blood	Cerebro-Spinal Fluid						Remarks on Duration of Cases, Progress, Nervous Symptoms, etc., and Mode of Death.
						C.Cms drawn off	Days before death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death
47	Kitambau	24-5-04	♂	24	+ 4 to cover.	18	17	+ 1 in 4 covers.	Slightly cloudy.	Much increased.	None.	9-6-04	Admitted to hospital beginning of March. Started for England April 29. Weakness increased during voyage and sores a marked symptom. Admitted Royal Infirmary, Liverpool, May 24. Slept almost continuously before death.
49	Tomi	24-5-04	♂	17	+ 5 to cover.	4	25	3 covers. 2 centrif.	Clear and limp.	Slightly increased.	None.	..	Boy from Kinshassa Mission, Leopoldville. Duration of case about five months. No sleep symptoms. Progressive wasting and weakness.
		15-6-04			+	30	1	+ many. 5 to field.	Clear.	Increased.	None.	17-6-04	
		17-6-04			+	45	P.-M.	2 covers.	Slightly cloudy.	Much increased.	None.	..	
50	Nbeta	9-11-03	♂	24	..	35	23	+ many.	Slightly cloudy.	Much increased.	None.	1-11-04	An advanced case seen at Boma. Marked somnolence. Admitted August 1.
51	John Paka	26-10-03	♂	28	+ 2 to cover.	10	..	+ 6 covers.	Clear and limpid.	Very scanty.	A few.	..	An early case. A Sierre Leone boy seen at Boma. No symptoms and no complaint.
52	Louis	16-10-03	♂	16	+ 11 to cover.	15	..	+	Slightly cloudy.	Increased.	A few.	Died.	An advanced case in hospital at Boma.
53	Somi	13-10-03	♀	22	+ 6 to cover.	20	..	+ many.	Slightly cloudy.	Increased.	None.	Died.	An advanced case seen in hospital at Boma.
54	Bulumbu	29-10-03	♀	16	+ 1 cover.	10	..	+	..	..	..	Died.	An advanced case seen at Boma.

TABLE II.—DOUBTFUL CASES NOT PROVED TO BE SLEEPING SICKNESS

No.	Name	Date	Sex	Age	Trypanosomes in Finger Blood	Cerebro-Spinal Fluid						Remarks on Duration of Case, Prominence of Sleep, or other Symptoms, etc., and Mode of Death
						C.Cms. drawn off	Days before death	Trypanosomes	Clear or Cloudy	White Cells	Red Cells	Date of Death	
1	Mwandu ..	22-12-03	♂	21	2 covers.	20	8	6 covers.	Clear.	Scanty.	A few.	31-12-03	Apparently a case of miliary tubercle. No symptoms of sleeping sickness.
2	Lembu	24-12-03	♂	23	..	8	9	5 covers.	Clear	Scanty.	A few.	2-1-04	Probably a sleeping sickness case. Extreme emaciation.
3	Salabantu ..	2-12-03	♂	19	..	15	..	4 covers.	Clear and limpid.	Scanty.	None.	..	Discharged as fit. No symptoms of sleeping sickness.
4	Saoka ..	7-1-04	♂	17	..	18	..	3 covers. 2 centrif.	Clear and limpid.	Very scanty.	None.	..	A doubtful case, with symptoms of dulness and childishness, admitted December 26 and discharged as fit March 23, 1904.
5	Lost ..	10-1-04	♀	24	..	14	9	5 covers.	Clear and limpid.	Scanty.	None.	1-1-04	A doubtful case, with marked emaciation and some sleep symptoms.
6	Kanyuki	22-1-04	♂	24	..	18	33	3 covers. 3 centrif.	Clear and limpid.	Scanty.	None.	25-2-04	A doubtful case, admitted for severe dysentery. Extreme emaciation but no dulness or drowsiness.
7	Sungura	5-2-04	♂	18	..	40	9	4 covers. 2 centrif.	Milky.	Large deposit of pus.	None	6-2-04	Doubtful history of sleeping sickness, no emaciation. Retraction of head and convulsive movements of arms. Died a few hours after admission. *P. M.* Purulent meningitis and ethmoidal sinuses full of pus.
8	Fatiafa	8-2-04	♀	20	2 covers.	22	4	3 covers 2 centrif.	Clear.	Increased.	A few.	12-2-04	A septic case, with huge collection of pus in arm when admitted.
9	Ponger .	10-2-04	♂	24	3 covers.	15	6	1 cover.	Greenish-yellow cloudy fluid.	Pus.	None.	10-2-04	Semi-comatose when admitted. Somewhat similar case to No. 8. Excessive continuous rigors, and pus oozing from nostrils. Violent spasmodic contraction of limbs.
10	Kabinda	27-2-04	♂	18	1 cover.	25	..	2 covers 2 centrif.	Clear and limpid.	Very scanty, almost none.	None	.	Came to hospital half an hour asking for treatment for craw craw.

In studying the column in Table I, in which is enumerated the number of days intervening between the puncture and the date of death, it will be seen that the probability of trypanosomes being found in the cerebro-spinal fluid tends to increase as one nears the fatal termination. This is shown by the following two Tables compiled from the forty-nine cases under analysis.

TABLE III

Thirty-five cases known to have proved fatal at the date of compilation of Table I

Days before Death	Number of Punctures	Trypanosomes present	Trypanosomes absent
Within ten days	27	14	13
Between ten and thirty	19	8	11
Between thirty and one hundred and ten ...	11	4	7
Totals	57	26	31

TABLE IV

Fourteen cases not known to be fatal at the time of compilation of Table I

Days before Death	No. of Punctures	Trypanosomes present	Trypanosomes absent
The majority are comparatively early cases, and presumably many days from death	17	6	11

A larger series of lumbar punctures in the earlier stages would be of the greatest interest.

In the Congo disease, as we have seen it, mainly at Leopoldville, there is an endless variety of types. In most cases sleep is absent, in some dulness and apathy are prominent, in others nervous symptoms and mania are conspicuous, while a proportion of cases have only progressive emaciation and fever. In classifying these symptoms it does not seem possible to definitely connect them with the appearance or non-appearance of trypanosomes in the cerebro-spinal fluid.

Cases 8 and 17, each of them punctured several times with negative results, except in one instance, were conspicuous for general absence of all symptoms except fever and emaciation. They each were able to walk and retain their faculties up to the time of death. Case 13 is in many respects similar to the foregoing two, but developed increased drowsiness some time before death, although showing no parasites in the cerebro-spinal fluid.

On the other hand we have Cases 20, 26, and 32 all showing trypanosomes repeatedly in the cerebro-spinal fluid, and all conspicuous for sleep or other head symptoms, more marked in the later days.

Examples of long-continued mild mania are not infrequent, of which class Case 33 is a good example. This man's blood was examined on many occasions, but no trypanosomes were found until the lumbar puncture revealed them in his cerebro-spinal fluid.

On the whole one cannot say more than that the presence of the parasites in the cerebro-spinal fluid apparently tends to increase the gravity of the case, and predisposes to the more severe head symptoms and other complications likely to bring about a fatal termination. Only in such cases as 8 and 17 do I think the parasite can be said to be solely accountable for the death. In the vast majority of cases death is the result of complications, mainly bacterial.

As in the blood, where the appearance of a large number of parasites is frequently coincident with an unusually high rise of temperature, if the patient is not too far advanced in the disease to be irresponsive, so also the rare discovery of large numbers of parasites in the cerebro-spinal fluid is, I have found in several instances, coincident with an unusual rise in the temperature curve. This no doubt accounts for the occasional unexplained rises of temperature and aggravation of symptoms occurring where few or no parasites can be found in the circulation. An access of temperature is probably in these cases always coincident with the collection or the development of a crop of parasites in one or other of the organs or fluids of the body.

All cases punctured, whether with or without parasites in the cerebro-spinal fluid, had well-marked fever, characterized by an afternoon rise and a morning fall to near the normal, showing that no connexion can be traced between the commencement of the fever and the entry of the parasites into the cerebro-spinal fluid from the blood. Some of the cases in Table I died without ever having trypanosomes in their cerebro-spinal fluid, but showed nevertheless the characteristic temperature curve.

It would appear from Cases 26, 28, and 38, that just as in the blood, the parasites may come and go in the cerebro-spinal fluid irrespective of their presence or absence elsewhere in the system.

Case 23 shows that they may be in enormous numbers in the blood without appearing in the cerebro-spinal fluid, where, however, they do occur occasionally in large numbers as is seen in Cases 28, 38, 44, and 49, but in this fluid they are most frequently very scanty.

The amount of fluid drawn off is no indication of the total amount present. Occasionally the pressure is considerable, and in these cases very marked temporary benefit is often derived from the puncture.

Cerebro-spinal fluid with no admixture of blood or increase of white cells is as clear and limpid as distilled water. According to the amount of mixture with red

or white cells, or both, I have here described it as clear, slightly cloudy, or cloudy. If with blood only the cloudiness has a pink tinge, but if with white cells only it has no pink tinge. It is invariably clouded almost immediately after death by excess of white cells. The colour and extent of the cloudiness is best gauged by looking down and not through the centrifuge tube.

The fluid, as soon as drawn, should be centrifugalized gently for fully five minutes. It can then be poured off to the last drop into another tube, leaving only the resulting small deposit, which can then be picked up with a fine pipette, placed on a slide and systematically examined under a coverglass well ringed with vaseline, with a one-eighth or one-sixth objective, and a No. 4 eyepiece. If centrifugalized violently for a length of time the activity of the trypanosomes may be much decreased, and, consequently, the labour of searching for them more difficult, and if there is much deposit they may even be mutilated by the pressure of the cells. I have found it far better to centrifugalize the fluid a second time after the deposit from the first centrifugalization has been examined, for, owing to degeneration changes, which commence in the cells almost as soon as the fluid is drawn, it is best to examine it and fix some films without delay. It is imperative that the fluid should be centrifugalized a second or even a third time if possible, for, on two occasions at least, I have found trypanosomes in the second deposit and not in the first. If there is no deposit in the tube the lowest fluid should be pipetted without pouring off, for the parasites are easily poured away with the fluid.

With regard to the white cell elements, I have described them as very scanty, scanty, increased, and much increased, and I have assumed that very scanty is the normal condition. The difference between these various degrees is difficult to make out, and is apt to depend upon the amount of fluid allowed to remain with the deposit.

TABLE V

L.P.	Very Scanty	Scanty	Increased	Much Increased	Totals
Tryps. present	3	10	11	7	31
Tryps. absent	-	25	10	1	43
Total ...	10	35	21	8	74

The majority of the punctures come under the headings of scanty or increased, viz., forty-six per cent. under the former, and twenty-six per cent. under the latter, leaving about thirteen per cent. for both very scanty and much increased.

One might conjecture that where the cellular elements are increased the examination would be positive for parasites, but the following table shows that this is not so evident as might be expected.

Case 32 shows that, although a large number of parasites were found at each puncture, there was an apparent decrease of cells in the fluid. In Case 1–, no parasites were ever found in the cerebro-spinal fluid, and the cells were invariably scanty; and in the ten cases not proved to be sleeping sickness it will be seen that the cell elements of the fluid are almost invariably scanty. In the majority of the early Cases, 19, 39, 40, 42, 43, 47, 51, whether positive or negative, the cells are scanty or very scanty.

In Case 28 the cells seem to have disappeared from the fluid in much the same proportion as the parasites. In Cases 44 and 49 a very large number of parasites was accompanied only by a comparatively small increase of cells.

For those who are not familiar with the operation of lumbar puncture, I will describe the method I have found best.

The patient is placed on his right side, on a table if possible, with his knees drawn up to his face. After thoroughly cleansing his back with soap and water and again with alcohol or ether, cocaine is injected, with a short strong needle if the patient is a black man, both subcutaneously and deep into the muscles over the interspace above the last lumbar vertebra. This interspace is on a straight line drawn between the two iliac crests, and the needle should be passed half an inch to the left of the middle line, not midway between the two interspinous processes, but slightly nearer to the upper one. The next lower space between the sacrum and the last lumbar vertebra can be selected if for any reason it is desirable, but owing to the flattening of the canal in this situation the operation is not quite so easy to perform without drawing blood.

After waiting a few minutes the knees are adjusted so as to be exactly opposite each other, and while the assistant secures the position of extreme flexion, the tips of the fingers of the left hand are placed firmly upon the left iliac crest, leaving the thumb to indicate not only the interspace but the exact spot and direction as well.

The puncture needle is then passed through the skin, the precise direction again gauged, and the needle then passed on slightly upwards and towards the middle line, or downwards and to the right, with reference to the table. If the spot and direction have been well chosen, no bone is encountered, the passage of the needle point into the canal can easily be felt, and the clear fluid at once appears drop by drop. The syringe is then adjusted, and sufficient for examination is slowly drawn off. With a little practice and a docile patient no operation is easier, and I have performed it on the floor in native huts, in the open bush, in my tent, and in a canoe. Having learnt the exact spot and direction, the only difficulty is to gauge the depth to which the needle should be passed, for if the point is allowed to prick the cord or the membranes opposite, blood immediately appears and the results of the operation are valueless for statistical purposes.

With regard to anaesthetics, cocaine is the best. Cases of excitement or mania necessitate chloroform, but it is inadvisable to give chloroform if it can be avoided, for, in two cases, the struggle and subsequent exhaustion have I believe hastened a fatal issue.

The needle selected should be as fine as possible, consistent with sufficient strength to withstand the grip of the powerful back muscles, if in the early stages of the disease the patient is restless or insufficiently cocainised. In length it should be from two to three inches. It is important that the diagonal surface at the point should be as short as possible, and the actual point not too sharp. In no case should the syringe be used as a handle for the needle, but into the base of the needle should be screwed a metal handle, which, when the needle has been passed into position, can be substituted for a glass 10 c.c. serum syringe with a short rubber connexion. The careful sterilization of all instruments is of course necessary. Although the skin may be cleansed as thoroughly as possible, it cannot be sterilized, but, in my cases, no introduction of septic matter has resulted from the operation. It would, however, probably be wisest, after the cocaine has been injected, to cauterize the site of the puncture with some small cautery made for the purpose.

In the cases of septic meningitis, pus is frequently found in the ethmoidal or other sinuses, and the infection cannot be traced to the lumbar puncture. In Cases 7 and 9, in Table II, and others in Table I, symptoms of meningitis were apparent before the puncture was made, and in other cases death occurred from the same cause without lumbar puncture. The discovery of purulent lymph round the cord in Case 31 might possibly point to infection introduced with the needle, but in this case the symptoms did not commence till a fortnight after the puncture.

These notes are the outcome solely of work done in connexion with the Congo disease.

The duration of the cases in Tables I and II is gauged chiefly by the date of the commencement of symptoms, that is in many cases the date at which the patient finds himself unable to work, the actual duration probably being much longer. The disease can frequently be diagnosed by the intimate friends or fellow workmen of the patient long before he himself realizes it.

The total number of cases here recorded is too few to permit of any very definite statements, but I think it is sufficient to allow of the following provisional conclusions.

1. That in many cases the trypanosomes never find their way into the cerebro-spinal fluid, and in those cases in which they do they are more likely to be found towards the termination of the disease.

2. That the commencement of the fever or other symptoms is in no way co-related to the entrance of the parasites to the cerebro-spinal fluid.

3. That a large number of trypanosomes in the cerebro-spinal fluid is rare, but when it does occur there is usually an access of temperature.

4. That the parasites may come and go in the cerebro-spinal fluid as in the blood.

5. That enormous numbers may appear in the blood without appearing in the cerebro-spinal fluid, and, to some extent, *vice versâ*.

6. That when trypanosomes are present in the cerebro-spinal fluid its white cell elements are apt to be increased.

7. That in cases where the parasites gain access to the cerebro-spinal fluid early in the disease, mania and other head symptoms are more likely to be prominent.

A description of the various developmental forms of trypanosomes to be found in sleeping sickness cases in the cerebro-spinal fluid ; of the various cells of the fluid, in particular a peculiar large mulberry-shaped cell ; of its chemistry ; of certain large organisms with actively dancing particles, met with occasionally ; of the occurrence of nematode larvae and ova resembling those of *Ankylostoma duodenale* in connexion with the fluid in many cases, and of other matters of interest, must be left for a future publication.

A COMPARISON OF THE ANIMAL REACTIONS OF THE TRYPANOSOMES OF UGANDA AND CONGO FREE STATE SLEEPING SICKNESS WITH THOSE OF TRYPANOSOMA GAMBIENSE

(DUTTON)

A COMPARISON OF THE ANIMAL REACTIONS OF THE TRYPANOSOMES OF UGANDA AND CONGO FREE STATE SLEEPING SICKNESS WITH THOSE OF TRYPANOSOMA GAMBIENSE*
(DUTTON)

A PRELIMINARY REPORT[1]

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THE strains we have used in our work are as follows:—Three strains of *Trypanosoma gambiense* from Gambia. (See below). Two strains from Uganda: (1) from the cerebro-spinal fluid of a case of sleeping-sickness; and (2) from the blood of a case of trypanosome fever. We take this opportunity of thanking Colonel D. BRUCE, R.A.M.C., F.R.S., to whom we are indebted for these two strains. Four strains from the Congo Free State: (1)[2] from the cerebro-spinal fluid of a case of sleeping sickness; (2)[2] from the blood of a case of trypanosome fever; and (3) and (4) from the blood of two natives at present under observation in Liverpool.

Trypanosoma gambiense (DUTTON).—Three strains of *Trypanosoma gambiense* were brought home by Dr. J. E. DUTTON and Dr. J. L. TODD, from their Senegambia expedition[3]; of these three, which are called 'Gunjur,' 'Lammin,' and 'Q' strains, we have worked almost entirely with the 'Gunjur' strain, which was derived from the boy at Gunjur, case 4.[4] Since that time the strain has been passed through a great number of animals under varying conditions; the direct strain is that passed from rat to rat, to ascertain whether increased virulence or attenuation of the trypanosomes could be produced. It is not our purpose to present here the results, but

* *Reprinted by permission from the publishers of the* LANCET, 14th *May*, 1904

1. In the forthcoming Thompson Yates and Johnston Laboratories Reports a fuller report will be published, together with serum and agglutination experiments, and the results of therapeutic experiments.

2. Sent to us by our expedition to the Congo Free State.

3. J. E. Dutton and J. L. Todd, *First Report of the Trypanosomiasis Expedition to Senegambia* (1902), Liverpool School of Tropical Medicine. Memoir XI.

4. *Ibid.*

we believe that a definite increase of virulence, as well as an attenuation, can be achieved, the former by the passing of the trypanosomes through a large series of animals of the same species, and the latter by constantly changing the species of animal employed.

Rats.—Young rats, thirty experiments, shortest incubation two days, longest thirty-five, average from four-and-a-half to seven-and-a-half days. Usual duration from twenty to forty-one days. Some have survived one hundred and thirty-two days. Adult rats, thirty-three experiments, incubation from four to forty-seven days, average eight-and-a-half days. Duration from forty-five to three hundred and eighty-eight days. Some rats inoculated in Senegambia in November, 1902, still survive, but their blood is negative microscopically, and non-infective. The parasites are present in the blood of both young and adult rats in fair quantities, though in many of the animals they are not constantly present, being at one time numerous in the blood, and a few days later absent altogether, or only demonstrated after a most careful search.

Mice.—Twenty-five experiments. Incubation period from one to thirty-seven days; average from four to seven days. Usual duration from eleven to fourteen days. In some cases the parasites have been very numerous, and continually present in the blood, but very often the animal shows only a few parasites, or there may be a marked irregularity as to the appearance and disappearance of the organism.

Guinea-pigs.—Ten experiments. Three guinea-pigs have become infected after twelve, fifty-three, and seventy-three days, respectively, and have lived three, four, and eight months. One, Experiment 114,[1] inoculated May 13 and positive twelve days later, never showed parasites again in its peripheral blood until September 11. On November 1 thirty to a field[2] were observed. The trypanosomes continued to increase in numbers, and on December 3 reached eighty to one hundred to a field. On December 20 the numbers decreased and death ensued on January 4. A guinea-pig, Experiment 133,[3] inoculated on July 20 from a rat, was positive on September 11, parasites became very numerous on November 1 (twenty to field), and continued so to the end on November 20. Rupture of the spleen was the cause of death. Four guinea-pigs, inoculated one hundred and twenty-four days ago with large quantities of blood containing numerous trypanosomes, have remained negative up to the present time, despite re-inoculations. Their controls—*i.e.*, rats and rabbits—became infected in the usual time. Three guinea-pigs, inoculated on March 7 from rat 279A with large doses of blood containing countless trypanosomes, showed parasites in their blood in twelve hours in two cases, and in three days in the other. The

1. J. L. [illegible] J. L. Todd, *First Report of the Trypanosomiasis Expedition to Senegambia* (1902), Liverpool School of Tropical Medicine. Memoir XI.

2. We have, throughout, used three-quarter inch square cover-slips, and examined with one-sixth inch objective, and No. II eye piece.

3. Dutton and Todd, *loc. cit.*

parasites were seen in their blood for a few days (about twenty-four to a cover). Since March 20 these animals have been negative.

Rabbits.—Incubation period from five to fifteen days; average from seven to nine days. Duration from fifty to one hundred and twenty-eight days. In some cases the organisms have been fairly constant in the peripheral blood, in others they appear and disappear at irregular interva s, and the numbers vary from a few to twenty to a field. In these animals loss of weight and diminution of red cells and haemoglobin are constant features of the disease. In only one rabbit, which lived one hundred and twenty-eight days, have we noticed a purulent discharge from the nose, eyes, etc., with loss of hair, and then only in the last six weeks of its existence.

Cats.—Two experiments, both inoculated intravenously. Experiment 422, inoculated March 12 from a mouse. Trypanosomes were observed on March 19. Parasites were constantly present, the numbers usually being small. The temperature rose on March 20 to 104·4° F. and on the 22nd to 104·6°. Some loss of weight and anaemia have been observed. Experiment 447, inoculated March 22 from a rat; positive on March 26. Parasites were constantly present and in fair numbers—often one to each field. No rise of temperature was observed.

Puppies (from three to seven months).—Three experiments. Incubation periods, five days after intravenous and ten days after intraperitoneal and subcutaneous inoculation. Duration from thirty-three to forty-three days. In two cases the parasites were to be found almost constantly and in fair numbers which increased in the later stages of the disease; before death the blood became negative again. In the remaining experiment trypanosomes were only to be found at intervals and in small numbers. Loss of weight occurred in all three, and in two cases there was a marked diminution in the number of red corpuscles with a corresponding decrease in the percentage of haemoglobin. Subnormal temperature was recorded in one case before death.

Goat.—Small female, Experiment 518. Inoculated intraperitoneally on April 14 from a rat showing numerous trypanosomes. Strain 'Lammin.' Parasites appeared in the blood on April 21, but have not been found since. No rise of temperature nor other symptoms have yet been observed.

Donkey.—Inoculated subcutaneously on February 23 from a rat. Positive on March 9. Parasites were found on rare occasions, and then only in very small numbers. There was no definite rise of temperature. Some diminution in the percentage of haemoglobin and the number of red cells has been observed.

Monkeys.—Macacus rhesus, Experiment 311. This monkey had been infected by Dr. H. E. Annett with blood from the European Case H. K.[1] Parasites were found only at intervals and in small numbers, though the animal appeared to be very

1. H. E. Annett, *First Report of the Trypanosomiasis Expedition to Senegambia*, 1902, Liverpool School of Tropical Medicine, Memoir XI, p. 4.

ill and emaciated ; at the end of nine months it had quite recovered. In January, 1904, rats inoculated from it during the preceding four months not having become infected we decided to attempt to reinfect the animal. On January 29, thirteen months after its original infection, it was inoculated with blood from a rabbit ('Gunjur' strain). On February 6 parasites were found in the blood ; they were almost always present, though not in great numbers, up to March 24, from which date until death, on April 3, the blood remained negative. Very marked oedema of both upper and lower eyelids, intraorbital space, and eyebrows occurred on March 27 ; this persisted for three days ; no parasites were to be found in the oedema fluid. No other symptoms other than loss of weight and anaemia were observed.

Macacus rhesus, Experiment 517. Inoculated intraperitoneally on April 14 from a rat showing numerous trypanosomes. Strain 'Lammin.' Parasites appeared in the blood on April 16. Death occurred on April 18 from purulent and haemorrhagic peritonitis caused by a parasite found in the intestinal walls and not yet identified.

A chimpanzee, Experiment 134,[1] inoculated by Dutton and Todd in July, 1903. Parasites were rarely seen in the blood, and only in small numbers. After the third week in September trypanosomes were found only once in the blood, on January 27, when one was seen. On this date the temperature rose from its usual level of between 99° and 100° to 103·6° F., falling again next day. Parasites were not seen again before death, which occurred from broncho-pneumonia on February 10.

Sub-inoculations.—Two mice and a rat inoculated on November 20 did not become infected. Of the two mice and a rat inoculated on November 27 the mice did not become infected, while the rat was positive once, January 7, when one trypanosome was found in its blood. Two mice and a rat inoculated with large doses of heart blood immedately after death never became infected.

Symptoms.—There were occasional rises of temperature to 102° to 103° F. with no apparent cause. One of these occasions (November 27) one trypanosome was found in the blood. There were temporary loss of weight and appetite and falling off in condition towards the end of December, 1903. The animal subsequently improved and regained appetite. A blood count in July, 1903, showed haemoglobin 85 per cent. and red cells 8,360,000 per cubic millimetre. One made on February 6, 1904, showed haemoglobin 60 per cent. and red cells 4,540,000 per cubic millimetre.

Horse.—Experiment 87. The small bay stallion[2] inoculated in West Africa by Dutton and Todd in February, 1903, and brought to England in July, 1903, is alive and in good condition, and seems to have recovered. Trypanosomes have not been seen in its blood since it was brought to England. Two rats inoculated from it at the end of July became infected. Rats and mice inoculated on October 2 and

1. Dutton and Todd, *loc. cit.*
2. Dutton and Todd, *loc. cit.*

November 6 have not become infected ; and one large rat and two small ones inoculated on April 22 have not, so far, become infected. On October 9, 1903, the weight of the horse was 513 pounds. On April 26, 1904, it was 506 pounds. The animal shows no symptoms, its temperature is regular (from 99 to 101 F.), and its appetite is good. There is no oedema, and its coat is in good condition.

Strain Derived from Cerebro-spinal Fluid of Uganda Cases of Sleeping Sickness[1]

Rats.—1. Young rats : Twelve experiments. Incubation period from four to thirteen days ; average length, nine days. Parasites were fairly constantly present, but usually rather in small numbers. Duration from fourteen to forty-one days. 2. Adult rats : Twelve experiments. Incubation period from four to twenty days ; average length, thirteen days. Parasites were fairly constantly present in small numbers in the early stages of infection, later they became rare. Duration from sixteen to one hundred and forty-nine days.

Mice.—Incubation period from five to six days. Parasites were rarely present in the blood after the first appearance. Duration was from nineteen to forty-seven days.

Guinea-pigs.—Four experiments. None yet infected. Five weeks have elapsed since inoculation. Sub-inoculations into mice and rats so far have been unsuccessful. No symptoms have yet been observed.

Rabbits.—Incubation period from seven to nine days. Parasites are constantly present, tending to become more numerous as the disease advances. Marked and fairly rapid loss of weight is observed. The rabbits are still living. Anaemia is a noticeable symptom.

Cats.—One experiment. A large grey cat was inoculated intravenously from a rat. Incubation was six days. The temperature rose on the evening of the sixth day to 105° F.

Dogs.—One experiment. Inoculated intravenously from a rat showing fairly numerous parasites. Trypanosomes appeared in the blood on the seventh day. The temperature has remained normal. The animal has, so far, shown no symptoms.

Puppy.—One experiment. Age four-and-a-half months. Inoculated on March 20 from a rat. Trypanosomes appeared in the blood on March 27 and have since been constantly present, although not more numerous than from two to five to a field. The temperature has varied between 101° and 103° F. There was no rise with the appearance of parasites in the blood. Diminution in haemoglobin and red cells has been observed. The animal has lost strength considerably.

1. This was sent to us in a rat which had been inoculated from a monkey infected from the cerebro-spinal fluid of a case of sleeping sickness ; it was, therefore, only in its second passage.

Goat.—One experiment, a female. Incubation period, nine days. Parasites were fairly constant in the blood during the first week of infection, but afterwards were found only rarely. There was no rise of temperature with the appearance of parasites in the blood, but five days later, when eight trypanosomes were seen to the cover, the temperature rose to 104° F. No other symptoms have as yet been observed.

Donkey.—Inoculated on March 28 subcutaneously from a rat. On April 7 the temperature rose to 102·7° F., and on the 9th to 103·2°. A rat inoculated from the donkey on April 8 showed parasites on the 26th. The incubation period in the donkey was therefore ten days. Parasites were seen for the first time in its blood on April 18, and again on the 22nd.

Monkeys.—1. *Cercopithecus callitrichus.* Inoculated intraperitoneally on April 2 from a rat. Trypanosomes appeared in the blood on the 6th, and were constantly present for a week, when they became rare, occasionally being absent altogether. On the 7th the temperature rose to 105·5° F., and has since been irregular (with occasional rises to 104° to 105°, and over). No other symptoms have so far been observed, the appetite is preserved, and the animal is in good condition. 2. *Cercopithecus callitrichus.* Inoculated intraperitoneally on March 6 from a rat showing very few parasites. Trypanosomes did not appear in the blood before death, which took place from dysentery on the 10th. A monkey (*Macacus rhesus*), a rabbit, and one out of four rats inoculated with large doses of its heart blood became infected. Two guinea-pigs inoculated at the same time are still negative. Two mice inoculated with its blood died without becoming infected. 3. *Macacus rhesus.* Inoculated on March 10 intraperitoneally and subcutaneously with the heart blood of preceding monkey. Parasites were found in the blood on March 18, and were constantly present, although never very numerous, until April 6, when the animal died. On March 18 the temperature rose to 104·6°, with the appearance of parasites in the blood. During the last two days of life the temperature was subnormal (from 95° to 96°). Diminution of red cells and haemoglobin was observed. *Post-mortem*, purulent peritonitis was found due to a parasite found in the intestinal walls, and not yet identified. 4. *Macacus rhesus.* Inoculated on March 14 intraperitoneally with the heart blood of a rat. Trypanosomes appeared in the blood on the 18th, and were fairly numerous for four days ; on the 31st there were from thirteen to eighteen to a field. They became rarer again before death, which occurred on April 1. The temperature rose on the 18th, and on the 19th reached 105·8°, there being six parasites to a field at the time. The red cells decreased from 4,000,000 to 2,500,000 per cubic millimetre, and haemoglobin from fifty to twenty-seven per cent. 5. *Macacus rhesus.* Inoculated subcutaneously on April 22 with blood from a rabbit showing many trypanosomes. This monkey is not yet infected (April 27).

STRAIN DERIVED FROM CEREBRO-SPINAL FLUID OF SLEEPING SICKNESS, CASE 6,[1] IN THE CONGO FREE STATE.[2]

Rats.—Twenty-three experiments. Incubation period: young rats from three to nine days; adult rats from four to ten days. Duration from seventeen to one hundred and seventy-six days. Some of the animals have shown parasites fairly constantly, and in moderate numbers; in others the organisms have disappeared for some time or have been present in small numbers. We have rats which have lived as long as one hundred and seventy-six days, but in the blood of such animals the parasites are either found only in rare instances or not at all.

Mice.—Incubation from four to eleven days. Duration over ninety-two days. Parasites usually rare.

Guinea-pigs inoculated more than fifty days ago have not shown parasites as yet.

Rabbits.—Incubation after intravenous inoculation from three to four days. There was a slight rise of temperature on the day of infection and the following day.

Cats.—Two experiments. 1. Intravenous inoculation from a rat. Incubation period, eight days. Parasites were constantly present. On the twelfth day there were five to a field. 2. Intraperitoneal inoculation from a rat. Incubation period, eight days. No symptoms have as yet been observed.

Dogs.—Two experiments. 1. An adult dog inoculated intravenously from a rat. Parasites were seen on the fifth day. They were not numerous at first, but are increasing and constantly present. 2. A puppy, four months old, inoculated intraperitoneally from a monkey. Incubation period, eight days. No symptoms have as yet been observed.

Goat.—An adult, inoculated intraperitoneally from a monkey. The temperature rose on the evening of the fifth day to 106·5° F.; next day the temperature was 104·2°; a rat inoculated on this day is not yet positive. Parasites have not yet been seen in the blood of this goat.

Monkeys.—1. *Macacus rhesus.* Experiment 497. Inoculated intraperitoneally from a rat. Incubation period six days. Parasites have been constantly present in the blood and have steadily increased in numbers. On the day of the appearance of the parasites the temperature rose to 106° F. 2. *Cercopithecus callitrichus.* Inoculated February 15 intraperitoneally from a rat. Parasites appeared in the blood on February 20. The temperature on the 21st was 103·8° F. Trypanosomes were constantly present in fair numbers until April 5. Since then they have been rarely found, and in only small numbers. No symptoms were observed. The animal was in good condition. There was slight diminution of haemoglobin and red cells.

1. Dutton, Todd, and Christy, *Harvey Lectures*, [illegible] *Brit. Med. Journ.*, Jan. 23, 1904, pp. 189-198.
2. This strain was sent to [illegible] rat [illegible] from [illegible] sleeping sickness.

Strains derived from the Blood of Case 4[1, 2] and from Two Congo Natives at Present under Observation

Rats.—Incubation period from four to eleven days, average about seven days; duration, some of the animals have survived after eighty-seven days. In these animals trypanosomes have been scanty in the blood, with periods of some days to even weeks when none were to be found. This perhaps may be accounted for by the fact that the majority of the animals have been direct inoculations from the natives, whereas the sleeping sickness and *Trypanosoma gambiense* strains have been passed through a series of animals.

Mice.—Parasites were always very rare and the duration was indefinite in direct inoculations. In mice inoculated from one of the guinea-pigs sent to us from the Congo Free State (see below), the incubation period was three days and parasites were more frequently present.

Guinea-Pigs.—Two guinea pigs inoculated by us directly from the natives, and two young guinea-pigs inoculated from monkeys have been negative for a period of one hundred and forty-six days. Two adult guinea pigs inoculated from Case 4[2] on the same day by the members of the Congo expedition, and sent home while still negative, have shown parasites for the first time in their blood on the seventy-ninth and one hundred and thirty-fourth days after inoculation. No symptoms have as yet been observed. They are still living one hundred and fifty-two days after inoculation.

Rabbits.—Incubation, direct inoculations nine and eleven days; sub-inoculation from rat ten days. Duration from twenty-one to eighty-seven days. Parasites have been fairly constantly present but only in small numbers. Loss of weight, slight rise of temperature, and anaemia have been the only symptoms observable.

Monkeys.—Macacus rhesus. Two have been inoculated intraperitoneally directly from the natives. Experiment 331. Inoculated on February 9. Parasites appeared in the blood on the fifth day. On the next day the temperature rose to 104·9° F., the following day it registered 105·8°; at the same time the parasites were observed to increase in numbers. Trypanosomes were constantly present at first. On March 5, there were from twenty-five to thirty to a field. About the middle of March the trypanosomes became scanty and were not found at all after March 17. Death occurred on March 25. Rises of temperature were observed in this monkey coinciding with temporary increase of numbers of parasites in the blood. Experiment 316. Inoculated on February 6. Parasites appeared on the 13th, and at the same time the temperature began to rise, and on the 19th it registered 104°, up to the end of March parasites were constantly present in its blood, since that date they have been scanty and sometimes absent. On March 27, marked oedema of the upper and lower eyelids, especially the left, was observed. This persisted for three days; the puffiness was confined entirely to the eyelids; no parasites were found in the oedema fluid. At

1. [illegible] and therefore in its first passage. 2. Dutton, Todd, and Christy, *loc. cit.*

this time the appetite was poor, and the animal seemed to be failing. From April 15 to 22 parasites were present in fair numbers again, but are now once more scanty. No rise of temperature was associated with this temporary increase. Slight diminution of haemoglobin and red cells has been observed. The animal is now in better condition than it was a month ago.

Strain derived from the Blood of Trypanosome Fever Cases in Uganda

Rats.—Incubation from twenty-four to thirty-one days. Duration from one to four months. This strain was an attentuated one and has died out. Parasites were rarely present, and only in very small numbers.

Comparison of Symptoms in Animals inoculated with the above different Strains

It will be seen that our results have been practically the same whatever the strain used. In rats and mice the same chronic disease, periodicity in appearance of parasites, and absence of symptoms are in all cases observed as were described by Dutton and Todd. M. Brumpt and M. Wurtz have described[1] very marked symptoms in mice and rats inoculated from Congo sleeping sickness cases—*e.g.*, progressive emaciation, intermittent paralysis of the posterior quarters, oedema of the perineum, and sometimes acute nervous affections. We have observed none of these symptoms ; occasionally we have noted slight oedema *post-mortem*, but never in sufficient degree to be detected before death. In guinea-pigs there is with all strains the same lengthy incubation period. In those infected up to the present (with Gunjur and Congo blood strains) there is the same more or less chronic disease, characterized by loss of weight and constant presence of parasites in the blood. In rabbits we have produced with all strains the same chronic disease with fairly constant presence of parasites, loss of weight and anaemia. In cats the disease is the same with all strains, with rise of temperature on appearance of parasites, fairly constant presence of parasites, and absence of other symptoms so far as we have yet observed. In dogs and puppies there are no differences to be noted. Incubation periods are the same, and whatever strain be used there is the same constant presence of parasites in the blood, with loss of weight and anaemia. In goats and donkeys no differences have been observed between the strains used. In monkeys infection is readily produced with all strains, even with very small doses, and parasites are fairly constantly present in the blood, often in considerable numbers. Similar symptoms are observed with the different strains—*viz.*, slight loss of weight, anaemia, rise of temperature, especially with the first appearance of parasites in the blood, and occasionally localized oedema. We have observed no marked tendency to sleep in our monkeys ; when a

1. Brumpt et Wurtz : [illegible], Tome lvii, 1924, No. 12, Avril 1er pp. 567-73.

monkey is ill it sits on its haunches with its head between its knees ; this position, which has been termed the typical sleeping sickness position, is not characteristic of trypanosomiasis or 'sleeping sickness' ; it is the position assumed by any sick monkey from whatever disease it be suffering. We have noted no nervous symptoms at all.

In stained specimens we have not observed any differences between the trypanosomes of Uganda and Congo sleeping sickness cases on the one hand and *Trypanosoma gambiense* (Dutton) on the other. In the same species of animals and at corresponding stages of the infection the size and appearance of the former trypanosomes are precisely the same as those of the latter as described by Dutton and Todd and since observed by us. In rats inoculated either directly or from monkeys inoculated directly they present the same stumpy and long forms, the former being more numerous in the early stages than in the later. After passage through some generations of rats the stumpy forms show the same tendency to disappear. In rabbits trypanosomes of all strains show the same preponderance of short stumpy forms as compared with rats, mice, and guinea-pig, while in guinea-pigs, so far as we have yet observed, there is the same greater tendency to length in most of the forms met with. In no animals infected with either the Uganda or Congo sleeping sickness trypanosome have we ever seen any form differing in measurements or appearance from *Trypanosoma gambiense*.

Pathological lesions.—In none of our animals have we found anything differing from the lesions described by Dutton and Todd. Enlargement of the spleen is a feature in all the animals, more especially in rats and mice. In a guinea-pig, Experiment 133 (Gunjur strain), which died forty-two days after infection, rupture of the spleen was found, the rupture extending directly across the organ on its upper surface and near the posterior end for about one and a quarter inches. A profuse haemorrhage occurred and the animal bled to death. No history of an injury is known. Another guinea-pig inoculated with *Trypanosoma dimorphum* (Dutton and Todd)[1] has died from rupture of the spleen. This case will be published in a forthcoming report on *Trypanosoma dimorphum*. The glands are very little, if at all, enlarged, and there are no haemorrhagic glands to be met with as in animals infected with *Trypanosoma dimorphum*. Petechial haemorrhages are rarely seen. In monkeys the mesenteric glands are enlarged, but this is without significance, as all our monkeys were infected with intestinal parasites. No macroscopical changes in the nervous system have been noted. In none of our animals, whether allowed to die or killed for special purposes, have we been able to find trypanosomes in the cerebro-spinal fluid, although the blood may have contained many trypanosomes, nor have any of the animals inoculated with this fluid ever become infected.

[1] [illegible] Mem. [illegible] Roy. [illegible] Soc., tome cxxxvii., 1914, p. 733.

In the majority of animals which have died we are unable to say definitely that trypanosomiasis was the sole cause of death. Very frequently an intercurrent affection has occurred which, the animal's vitality having become impaired, has caused death. We would instance in rats broncho-pneumonia, caseous lung disease, and enteritis. In rats which have survived a few to many months it is exceedingly rare to find a single parasite,[1] nor has the negative blood appeared to be infective. Experiments are being conducted along these lines. In the majority of cases those rats which have been negative for months die without the presence of trypanosomes being again recognized. In some cases, however, rats which have been negative for months have at death once more shown parasites. As instances of this the following experiments are given.

Rat 95a[2] ('Q' strain) was inoculated on March 17, 1903, from horse Experiment 87; incubation period, eight days; parasites were found at irregular intervals and in small numbers. On September 13, 1903, a single parasite to a whole cover-slip preparation was seen, and the animal continued negative until its death on March 24, 1904, three hundred and sixty-five days after infection. At the necropsy a few parasites were found in the heart. Animals inoculated from it have not yet shown the infection.

Rat, Experiment 89[3] ('Lammin' strain). Inoculated February 26, 1903, from rat 26; incubation, eighteen days. Trypanosomes were present in its blood until April 21. From that time parasites were never seen except on the following dates, July 27, September 7, and November 1, 1903, until its death on March 15, 1904, three hundred and sixty-six days after infection. At the necropsy complete red hepatization of the whole of the left lung was found. The left pleural cavity contained over five cubic centimetres of slightly yellowish clear exudate containing one parasite to three fields. Animals inoculated with this exudate became infected, and from these sub-inoculations we have been able to infect a goat Experiment 518, and a monkey, Experiment 517.

We have observed that animals with extraordinary numbers of trypanosomes in their blood usually exhibit some lesion which tends to impair their vitality. The following experiment is a good example of this. A rat, 279a ('Gunjur' strain), inoculated on December 30, 1903, from a guinea-pig became positive on January 7, 1904. From that time until it was killed on March 22 the parasites were constantly present in increasing numbers in its blood. At the necropsy caseous lung disease was very far advanced, involving both lungs. Its blood on examination showed trypanosomes in countless uumbers. Two rats, two mice, three guinea-pigs, one rabbit, and a puppy were all inoculated intraperitoneally with heart-blood. Twelve hours later the mice and rats, the rabbit and two guinea-pigs were found to be positive, the rats and mice having as many as three to eleven to a field, the rabbit two hundred and forty to the cover-slip preparation, and the two guinea-pigs eight to the cover. The puppy did not show parasites in its blood until five days later.

Very little, if any, immunity is conferred by infection with *Trypanosoma gambiense*. The two following experiments are of interest in this connexion.

1. A piebald rat was inoculated directly from Mr. Q. by Dutton and Todd on November 3, 1902, Parasites were found in its blood on November 12, and again on February 27, 1903. After this the blood was always negative. On November 23, 1903, it was reinoculated intraperitoneally from a rat ('Gunjur' strain) showing very numerous trypanosomes. It became infected, and on December 9 its blood was swarming with trypanosomes. Death took place on December 26.

2. A monkey (*Macacus rhesus*) infected by Annett from H. K. (Dutton's original case) in 1902 recovered, its blood being non-infective to rats. On January 29, 1904, it was reinoculated (Experiment 311) from a rabbit ('Gunjur' strain), and became infected (see above).

As one would expect, there is no transmission of immunity to offspring. Several of the young rats which we have infected have been born from parents which either were infected at the time or had

1. This is also the case in other animals. See chimpanzee experiment.
2. Dutton and Todd, [illegible].
3. *Ibid.*

recovered from an infection. And one guinea-pig (Experiment 216) which we infected with 'Gunjur' strain was born from a guinea-pig infected at the time (also with 'Gunjur' strain). There is a certain amount of natural immunity or resistance to the human trypanosome to be met with in individual rats and other animals. Every now and then we have come across animals which have exhibited this feature. For example, of two rats A and B of the same size, inoculated at the same time with equal amounts of virulent blood from an infected animal, A will become infected while B remains uninfected or shows a prolonged incubation period. Again, A receives a larger dose than B; it frequently happens that B will show the infection earlier than A. Guinea-pigs show considerable resistance to infection. As instances of this we would mention those inoculated from Rat 279A (see above). Baboons (*Cynocephalus sphinx*) have up to the present been absolutely refractory.

Conclusions

1. The trypanosomes found in (*a*) cerebro-spinal fluid of Uganda sleeping sickness cases, (*b*) cerebro-spinal fluid of Congo Free State sleeping sickness cases, (*c*) blood of Uganda trypanosome fever cases, and (*d*) blood of Congo Free State trypanosome fever cases, are all identical in animal reactions and morphology with *Trypanosoma gambiense*. The specific name *gambiense* (Dutton) must therefore for the future include the trypanosomes from the above-mentioned sources.

2. There seems to be no acquired immunity against infection.

3. There is no transmission of immunity to offspring.

4. An animal which seems to have recovered may months later show parasites once more, apparently as the result of lowered vitality.

TWO CASES OF TRYPANOSOMIASIS IN EUROPEANS

TWO CASES OF TRYPANOSOMIASIS IN EUROPEANS

(Third Interim Report of the Expedition of the Liverpool School of Tropical Medicine to the Congo, 1903) *

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THE following cases seem well worthy of record since they tend to indicate with what uniformity the accepted signs of the disease may be expected to occur in Europeans infected with *Trypanosoma gambiense*.

The completeness of the history of the onset of the disease in Cases I and II makes them particularly interesting. The history of Case I is compiled from notes and temperature charts taken by the patient's husband during her illness. Case II was seen very soon after the probable date of his infection.

Case I

Mrs. G., *aet.* 35, a missionary. The patient's first stay in Congo was during the years 1895-99. During this period she had four small fevers, yielding to quinine—maximum temperature 103° F.; and a supposed attack of haemoglobinuric fever. One year without fever was then spent in England, and in June, 1900, patient, weighing then 147 lbs., again went to the Congo. Soon after her return she had three attacks of fever—maximum temperature, 104° F.—which were successfully treated by quinine; and from November, 1900, to July, 1901, she was in good health.

During the first days of August, 1901, the patient took a long canoe journey from Bolobo to her station at Bongandanga on the Lopori, and was severely bitten by 'river flies.' At the end of August, six days after the completion of the canoe trip, a severe fever commenced and lasted, without interruption, for twenty-five days. 'The highest temperature was 104° F., but the fever was very persistent and remained constant for two or three days at 103° F., then at 102° F., and so on. Quinine and phenacetin had no effect and the temperature was relieved only temporarily, but

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DISEASE.
Trypanosomiasis
Name Mrs G
Operation
Commenced
April 12th 1904
Temperature (Centigrade)
Temperature (Fahrenheit)
Trypanosomes present
Trypanosomes seen
Blood examined
Lymph Axillary
Spleen palpable
No Trypanosomes seen
Weight (30lb)
Day of Dis
Pulse
Resp
Date

unfailingly, by baths. For the next three months, weekly fever. First day, temperature about normal; second day, slight fever; third day, marked temperature; fourth day, 'always just one degree higher than third day' highest temperature recorded, 104·6° F.—fifth and sixth days, temperature much lower; seventh day, 'about normal.' From January to April, 1902, the temperature ranged between 99 and 100° F., and was never normal.

In January, and again in February her eyes, particularly the left, were 'inflamed,' and five days were spent with bandaged eyes in a darkened room. At the end of February, and during March, while on her way from her station to the sea-coast, four more attacks of fever occurred—temperature rising to 102°-103° F. During the voyage to England, where she arrived at the end of April, 1902, the patient's temperature gradually fell to normal. She remained in Europe until August, 1903, and then again returned to Africa. While at home she, on two occasions, suffered from fever, rising to 103° F.; quinine efficacious. During June, 1902, and again in January, 1903, her eyes were once more affected, and oculists were consulted. At various periods during her stay in Europe 'red patches' as large as a 'half-crown piece,' lasting for three or four days, appeared on her legs; they were tender, and the surrounding skin seemed hard. At one time patient's joints seemed stiff, at another she suffered from an 'inflamed throat. Three months were spent in Switzerland, the patient gained rapidly in health, and on leaving for Congo, August, 1903, seemed well, and weighed 145 lbs. Her medical history from her last arrival at the Congo to April, 1904, when we first saw her, is as follows:—

'*October* 10, 1903. Fever on the river steamer; lasted for two days; maximum, 102° F.

'*November* 9. Still on steamer; temperature suddenly rose to 105° F., reduced by bath; throat bad next day, relieved by gargling; discharge of matter for two days. On Tuesday, November 10, Wednesday, and Thursday, slight fever. Friday, 13, 5 a.m., 105° F., bath; 10 a.m., 105° F., bath; 1 p.m., 105° F., bath; 3.30 p.m., 107° F., bath; 8 p.m., 105° F., bath; the temperature fell to about 101° F. after each bath; patient delirious.'

'*November* 14. Patient too weak to walk, was carried from the steamer; highest temperature, 102° F. At 2.30 on the morning of the 15th the temperature rose to 105° F., a bath was given, and temperature brought down. On the 16th the temperature was 100° F., and on the 18th normal. There was no more fever until March, 1904.'

For two or three weeks she was apparently quite well. About Christmas, 1903, severe headaches commenced; about the middle of January these began to be accompanied by vomiting. At first the vomiting and headache 'appeared at irregular intervals, later as follows:—'First day, comparatively well; second day, malaise with slight headache; third day, bad headache, vomiting two to six times (on one

occasion eight times). There was no tenderness or pain, save headache, and no nausea or loathing of food. On the bad days an attempt at any exertion, even to read a letter, was certain to precipitate an attack of vomiting. About February 14 there was vomiting, once or twice, on alternate days. Took Liquor Arsenicalis, two to six drops three times a day.'

March 10. Stopped arsenic ; left her station for a change.

March 16. Headache and vomiting.

March 17. Severe vomiting, bile-stained vomitus.

March 18-20. Well.

March 22. Vomiting and headache, next day emesis more severe ; vomitus bile-stained.

March 24. Fairly well.

March 25. Severe headache, vomiting, fever (maximum 104·4° F.) The fever gradually lessened during the two following days, and from March 29 to April 12 patient was 'quite well.'

Quinine was given during this fever, but was, probably, never retained, since the ingestion of anything, liquid or solid, provoked emesis.

Physical examination.—April 15, 1904. General condition : Well-made woman ; height, 5 feet 6 inches ; weight, 126 lbs. ; rather anaemic appearance ; complains only of shortness of breath and of becoming easily fatigued.

Skin : No erythemata ; no distinct oedemas, although the skin of legs has a distinctly doughy feel ; on scratching skin capillaries contract.

Lymphatic glands : Slightly enlarged, palpable in axillae and neck.

Circulatory system : Slight venous pulsation in neck ; slight epigastric pulsation.

Heart : Apex beat normal in position ; cardiac dulness normal ; no thrill over heart or in neck ; sounds, a slight blowing systolic murmur limited to apex area, the aortic and pulmonary second sounds are rather loud ; no venous hum in neck.

Pulse : Frequent (96), tension medium, regular in time and force, artery normal.

Respiratory system : Nothing abnormal subjectively or objectively.

Digestive system : Appetite good ; bowels fairly regular, occasional slight constipation ; tongue clean.

Liver : Dulness normal, no tenderness on pressure.

Spleen : Not enlarged nor tender.

Nervous system : No headache or pain ; sensation to pain acute ; sensation to touch, heat, cold, and distance between pin points perfect ; there were distinct localized hyperaesthetic areas on different parts of the body, under right nipple, at apex of heart and on shins, slightest pressure causes acute pain. Superficial reflexes normal ; knee jerks just obtainable. Mental condition normal.

Eyes : Pupils react to accommodation and light ; both discs definitely congested (left more than right).

Throat: Tonsils not enlarged, no redness.

Generative system: Menstruation regular, flow normal in amount, generally slight temperature on first day.

Urine. April 29. Twenty-four hours specimen (preserved with thymol), volume 1,100 c.cm.; acid, color normal; cloudy precipitate, Sp. Gr. 1,020 (82° F.); no albumen or sugar; urea, 1·85 grammes to 100 c.cm. urine.

April 30. Twenty-four hours specimen, volume 1,740 c.cms.; color, normal; acid, no albumin or blood; urea, 1·55 grammes to 100 c.cms. urine.

Faeces. Careful examination showed no signs of intestinal parasites.

Liquor arsenicalis five drops three times a day was prescribed, and the patient was directed to increase the dose by one drop every third day. This treatment was followed until the 3rd of June (twenty drops t.i.d), when symptoms of saturation were evident, and this drug was discontinued for a time and iron and arsenic pills were substituted.

During 1895-96-97 quinine, grains V, was taken daily as a prophylactic against malaria. Its use was discontinued as it was thought to be the cause of 'neuralgia.' From January, 1903, to the present about three grains have been daily taken.

April 21. Slight epistaxis; bleeding at the nose had occurred on three previous occasions, once in Switzerland, twice in Africa, always slight.

May 22. For past three days has had swollen wrists, first one then the other; to-day one side of face is swollen, no redness or tenderness, or evidence of insect bite; these swellings are fugitive, and last only for a day.

June 2. For last few days patient has complained of lack of appetite and loss of energy; the swellings on face and hands persist; a papular eruption has appeared on the chest.

The accompanying chart shews the type of temperature and the result of examinations for parasites during the first three weeks of our observations. On the 15th of April the parasites disappeared from the peripheral blood, and the temperature fell to normal. In spite of daily examinations of coverslips and periodic centrifugalization of blood, trypanosomes have not been again seen. The temperature (with one slight exception) has, during this period, always been normal.

Until signs of arsenical saturation commenced to show themselves the patient felt 'much better'; she felt stronger and was less easily fatigued. There has been a slight increase in body weight, and in the value of erythrocyte and haemoglobin estimations.

May 12	May 27
Haemoglobin, 68 per cent.	74 per cent.
Red Cells, 4,510,000	4,450,000
White Cells, 4,650	4,000

We have never seen malarial parasites in this case.

It was through the kindness of Mr. M., a missionary stationed at Leopoldville, and the husband of the case 'Mrs. M.,' described by Broden and Manson, that this case was brought to our notice. He felt convinced that he had, in October, 1903, seen an erythema on Mrs. G.'s forehead in every way similar to those which he had previously seen in each of the cases from the Congo described by Manson.

We have been unfortunate in never seeing this case when erythemata were present.

Case II

T., a steamer captain, *aet.* twenty-eight, serving his first term in Congo. Patient left Antwerp, November 26, 1903, and arrived at Leopoldville, December 30. He reached his station, a wood post for steamers, on the banks of the Congo, just below its junction with the Kasai, on December 31, and remained there until April 13, 1904, when he was invalided for 'fever' to Leopoldville.

Here he came under the care of Dr. Grenade, the State Physician, who found that quinine was without effect, and, suspecting the nature of the patient's fever, very kindly allowed us to study the case.

History.—Six years ago the patient spent eight to nine months in a cargo steamer plying between Sierra Leone and the Gold Coast; the steamer often remained in various ports for some little time. In spite of this he never had 'fever,' and in 1898 he returned to Europe. Since then, until leaving for the Congo, November, 1903, he had been employed on vessels plying between European ports. After frequent questioning, the patient admitted that during this period he had had very occasional 'fevers' preceded by a 'cold feeling,' and followed by sweating. No quinine was ever taken for these 'fevers.'

While on the East Coast of South America, during six months in 1894, he had yellow fever.

In 1901 he was in hospital for four or five weeks with rheumatism in legs and arms. With these exceptions, he has always had good health.

Complains of constipation since leaving Europe.

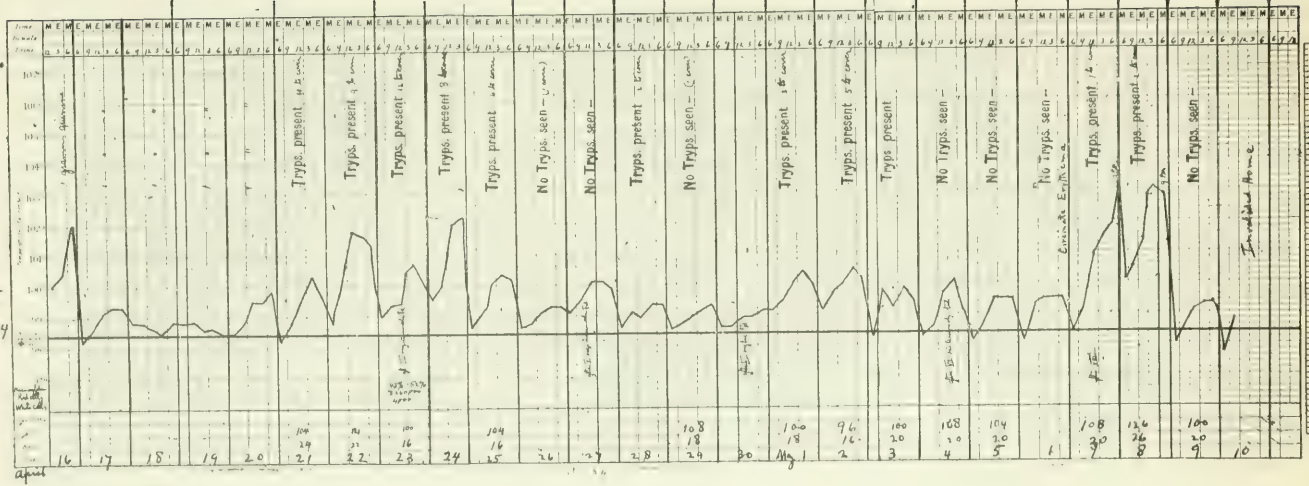
During his stay at the wood post he had five attacks of fever. The first commenced January 26, 1904, about four weeks after he reached the post, and lasted to February 3; during nine days he was ill, maximum temperature, 106·7° F.

The second attack occurred on February 17 and 18, two days' duration, fourteen days interval between it and first fever.

The third attack lasted two days, February 22 and 23, five days' interval between it and preceding fever.

The fourth fever also lasted two days, March 9 and 10, interval sixteen days.

During these last two fevers temperatures of 102·2° F. to 104° F. were recorded.


DISEASE
Trypanosomiasis
Name Capt. T.
Observations Commenced April 21st 1904
Tryps. present
No Tryps. seen
Tryps. present
Tryps. present
Tryps. present
Tryps. present
Tryps. present
No Tryps. seen
No Tryps. seen
Tryps. present
No Tryps. seen
Tryps. present
Tryps. present
Tryps. present
Tryps. present
Tryps. present
No Tryps. seen
No Tryps. seen
No Tryps. seen
Tryps. present
Tryps. present
No Tryps. seen
Inoculated Mouse
April
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
May 1
2
3
4
5
6
7
8
9
10

The fifth fever commenced March 17, and lasted eleven days, ending on March 27 ; temperature, 104° F. to 105·8° F.

The patient stated that the second, third, and fourth 'fevers' came on suddenly and without any premonitory signs ; for instance, while sitting at dinner he found himself in a high fever without any shivering fit or other prodrome. Before the first and fifth fevers, on the other hand, there was definite malaise, but no rigors.

From March 2 to April 10 he was alternately in bed and sitting in his chair ; on March 31 and April 1 and 5 his temperature was raised.

During these fevers and until his arrival in Leopoldville, April 13, he took about a gramme of quinine daily.

During the last fever he was greatly troubled by daily vomiting, which did not occur, however, unless something had been ingested.

The patient's friends say that he has lost flesh.

Physical examination.—April 18, 1904. Present condition : Man of average height and build ; distinctly sallow and anaemic appearance ; slight blepharitis (old-standing), complains of weakness ; says 'knees are weak ;' loses breath quickly.

Skin : Has a doughy feel, and is distinctly oedematous, this is most marked over ankles, where there is pitting ; there is no erythemata or other eruption ; dermatography not marked.

Lymphatic glands : Palpable, not enlarged.

Circulatory system : Heart, action rapid ; dulness, normal ; difference between first and second sounds, less marked than normal ; no bruits ; pulse, frequent, regular in time and volume ; artery, normal.

Respiratory system : Normal ; no complaint.

Digestive system : Bowels constipated, goes two to three days without movement ; tongue, flabby, not much furred, no tremor ; throat, normal ; appetite, fair.

Liver : Not enlarged (width in nipple line 6 cm.), a suspicion of tenderness.

Spleen : Just palpable ; slight tenderness.

Nervous system : Sensation to pain, touch, heat, cold, and distance apart of pin points, normal ; superficial reflexes, normal ; knee jerk, slightly increased.

Eyes : Left eye is seen by ophthalmoscopic examination to have a markedly congested disc, there is deep cupping ; choroidal vessels show very plainly.

Urine. April 29. Twenty-four hours specimen (preserved with thymol), volume, 660 c.cm., dark sherry color, acid ; urea, about 3 grammes to 100 c.cm. urine ; spectrum of urobilin, marked.

May 4. Twenty-four hours specimen ; volume, 1,075 c.cms., dark-brown sherry color ; acid, no albumen ; Sp.Gr. 1,016 (temperature, 79° F.) ; urea, 2·6 grammes to 100 c.cm. urine.

May 10. Twenty-four hours specimen ; volume, 700 c.cm. ; dark color ; Sp.Gr. 1,027 (temperature, 78·8° F.) ; acid, no deposit ; no blood or albumen ; urea, 2·6 grammes to 100 c.cms. urine.

April 30. Physical examination repeated, no change observed.

May 7. Patient drew attention to a redness on chest which he said was very obvious last night. On examination, red diffuse areas seen under nipple and on epigastrium, not itchy or painful; one annular area about 5 cm. in diameter on right lower costal margin, had slightly swollen periphery with injected vessels, while the centre remained uncoloured. Five diffuse injected areas, varying in diameter from 2 to 4 cm., were seen on back.

May 8. Says that temperature rose to 104° F. at about twelve last night. To-day there is marked oval ring of faint, slightly raised erythema, measuring 1 by 5 cm. just above the right eye; it is not tender or itchy, and the skin is distinctly thickened. The ring seen yesterday on right hypochondrium still persists, its capillaries are injected, and its general appearance is much the same as yesterday, its centre is yellowish; there is no extravasation of blood (glass slide test) in either of these annular areas. On left hypochondrium were more or less blotchy areas of redness, mixed with very faint greenish or yellowish discolouration.

Patient has more colour and looks better than when he was first seen, he has more appetite and says that he feels stronger and does not become so easily fatigued as when he first came to Leopoldville.

May 9. The ring of erythema over right eye has almost entirely disappeared, the blotchy areas on body are vanishing. Although patient's temperature has been about 103° F. for the past two days, he says that he has felt no inconvenience from it. His appetite has been good, and he walked about as usual.

May 10. Patient leaves Leopoldville, invalided home. The remains of ringed erythema are seen on chest. Malarial parasites were not seen in this case.

The first attack of fever occurred within six weeks of this man's arrival in Congo. He spent approximately the first week in the Free State in Boma, and then went as directly as possible to his station. In twenty-seven days after reaching the wood-post his illness commenced. It does not seem at all probable that he acquired his infection so long ago as 1898 when he was on the Gold Coast, nor do we believe that he became infected either at Boma or while travelling by train to Leopoldville. We are inclined to think that he became infected with trypanosomes after his arrival at his post. It, therefore, seems probable that the 'incubation period,' between the time of infection with *Trypanosoma gambiense* and the appearance of the symptoms associated with human trypanosomiasis, may be so short as four weeks.

It is extremely interesting to note in this connexion that *Glossinae* were extremely numerous at this post, situated on the river bank, and were a most disagreeable and constant pest.

SUPPLEMENTARY NOTES ON THE TSETSE-FLIES

SUPPLEMENTARY NOTES ON THE TSETSE-FLIES
(GENUS GLOSSINA, WIEDEMANN)

BY
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SINCE the publication of *A Monograph of the Tsetse-Flies* a little more than a year ago, our knowledge of these interesting insects, so important to the student of African trypanosomiasis, has been extended in various directions. It has, therefore, seemed advisable to embody these additions in a short paper, which it is hoped may not prove altogether unworthy of the attention of the members of this Section, and may serve to bring the author's Monograph so far as possible up to date.

In the work in question seven species of Tsetse-flies were recognized and described. But within the last few months an eighth species has been described under the name *Glossina decorsei*, by Dr. EMILE BRUMPT, from specimens recently obtained by Dr. DECORSE on the River Shari and the shores of Lake Chad.[1] An examination of some of Dr. DECORSE's specimens, however, kindly submitted by Dr. BRUMPT, shows that the supposed new species is in reality none other than *Glossina tachinoides* (WESTWOOD), which was described as long ago as the year 1850. In his Monograph, *Glossina tachinoides* was regarded by the present author as a variety of *Glossina palpalis* (ROBINEAU-DESVOIDY), the species that, since Colonel DAVID BRUCE's investigations in Uganda last year, has become widely known as the disseminator of *Trypanosoma gambiense*, now recognized as the cause of sleeping sickness. The study of further material, however, and especially of a long series of specimens obtained two months ago on the Benue River, Northern Nigeria, by Mr. W. F. GOWERS, and kindly presented by him to the British Museum, shows that *Glossina tachinoides* (WESTWOOD) is in reality a perfectly distinct species, nearly related to *Glossina pallidipes* (AUSTEN) but distinguishable at once, apart from its much smaller size, by the fact that the hind tarsi are either entirely dark, or, as in the female, are dark with the bases of the first three joints usually pale. The total number of species of Tsetse-flies now known

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therefore amounts to eight. In the paper already referred to Dr. Brumpt considers that *Trypanosoma dimorphon*, the parasite of nagana or Tsetse-fly disease in domestic animals, is carried by at least five of these species,[2] and he further states that the investigations that he is making upon sleeping sleepness lead him to suppose that this malady may also be transmitted by several species of Tsetse-flies. The mere possibility that this supposition may ultimately prove to be true is perhaps sufficient warrant for thinking that no detail concerning the morphological characters, distribution, or bionomics of any of the species of *Glossina* is without importance for those interested in the sanitation of tropical Africa. In the present paper, therefore, the eight species will be considered in order, and any new facts regarded as worthy of notice recorded under each, the arrangement adopted in the Monograph being adhered to, and *Glossina tachinoides* inserted in its proper place. At the end of the paper a revised 'Synopsis of species' will be given, which it is hoped may prove useful for the determination of specimens.

Glossina palpalis (Rob.-Desv.)

The form of this species designated in the Monograph as 'Var. *tachinoides* (Westw.)' must now be regarded as a variety which for the present may remain unnamed. It is characterized by the possession of pale femora, buff-yellow median stripe on the abdomen, and narrow pale hind margins to the abdominal segments. Specimens obtained by Drs. Todd and Dutton on the Gambia during the Gambia expedition of the Liverpool School of Tropical Medicine belong to this form, which may eventually have to be raised to specific rank. A second variety also has the femora paler than usual; the palpi, except the tips, pale; and the abdomen somewhat reddish-brown, with the pale area on the second segment oblong instead of triangular. Owing to the colour of the abdomen this form presents a certain resemblance to *Glossina pallicera* (Bigot). A specimen of variety No. 2 was obtained at Old Calabar on May 14, 1900, by Dr. Annett, of the Liverpool School of Tropical Medicine.

As many of the members of this Section are doubtless aware, our knowledge of the life-history of Tsetse-flies was originally due to Colonel Bruce, who, during his investigations upon Tsetse-fly disease, or nagana, among domestic animals in Zululand in 1895, discovered that the species studied by him —either *Glossina morsitans* (Westw.) or *Glossina pallidipes* (Austen) —'does not lay eggs as do the majority of Diptera, but extrudes a yellow-coloured larva nearly as large as the abdomen of the mother.'[3] Specimens of the pupa of this species, kindly supplied by Colonel Bruce, were described and figured on pp. 26-28 of the author's Monograph. Owing to the kindness of Colonel Bruce, Captain E. D. W. Greig, I.M.S., and Dr. Nabarro, all of the Sleeping Sickness Commission, who forwarded specimens from Entebbe, Uganda, it is now possible to describe the larva and pupa of *Glossina palpalis*.

Larva of Glossina palpalis

I have been enabled to examine a series of sixty-two larvae of this species, ranging in length from 2 mm. to [illegible] mm., but only one of these (the largest) can be regarded as adult. The colour of these specimens, which have been preserved in 5 per cent. formalin, varies from cream to buff yellow. In all the larvae the tumid lips on the last segment, as seen in the pupa, are plainly visible, and in a larva of $2\frac{1}{2}$ mm., which may perhaps be considered to be in the first stage (*i.e.*, before the first moult), the size of the lips is relatively, if not even actually, considerably greater than in a larva measuring $3\frac{1}{3}$ mm., which is perhaps in the second stage (*i.e.*, between the first and second moults). In the former stage, too, the lips are much wider apart than in the second, and the very young larva viewed from above may be said to be conical in shape, with a protuberance on each side of the truncate posterior extremity. In the second stage (larvae from 3 mm. to $3\frac{1}{3}$ mm. in length) the lips are nearer together, and separated by a much narrower interval than in larvae in the third stage (about $3\frac{1}{3}$ mm. in length and upwards), in which they have their final position, as seen in the pupa. In the first stage the lips, or anal protuberances, appear slightly brownish all over; in the second stage they are blackish at their extremity and at the margin of the intervening notch; in the third stage they are uniformly deep black, and the granules with which they are covered can now be easily discerned under an ordinary platyscopic lens. In the second and third stages the body of the larvae in front of the bifid anal extremity (twelfth segment) is seen to be composed of eleven clearly marked segments. In the larger larvae the tips of the mouth hooks can be seen slightly protruding from the cephalic end. The larva already referred to as being the only one that can be regarded as adult, measures [illegible] mm. in length, by 3 mm. in greatest width, and was obtained by Captain Greig, at Entebbe, Uganda, in April of the present year. In this larva, in the median ventral line, each of the segments from the fourth to the tenth shows on its anterior margin a narrow ridge, measuring about $\frac{2}{3}$ mm. in transverse width. The object of these ridges may be to assist the adult larva on extrusion to crawl away to some hiding place in which the pupal stage may be assumed.

All of the larvae here referred to were deposited by the parent flies in boxes, and, since all, with a single exception, are immature, it follows either that *Glossina palpalis* differs from the species described by Colonel Bruce, in that the larva feeds and grows outside the body of the mother after extrusion, or else that the parents of these larvae, probably owing to their being in captivity, gave birth to their offspring prematurely. The latter supposition would appear to be the more reasonable.

Pupa of Glossina palpalis

The pupae examined were all obtained at Entebbe, Uganda—those forwarded by Dr. Nabarro in September, 1903, while others were collected in April, 1904, by Captain Greig. Additional specimens were sent home last year by Colonel Bruce

The pupa varies in length from 5¼ mm. to 6½ mm., and in the greatest width from 3 mm. to 3⅓ mm. In general appearance it is precisely similar to that of the Zululand species, figured on page 27 of the author's Monograph. The tumid lips on the last segment, however, are much closer together, the space between them being reduced by quite one-half, while the lips themselves are somewhat larger, and covered with sparser and therefore more conspicuous granules. The notch between the lips is somewhat deeper, and consequently approaches slightly closer to the preceding segment than in the species figured in the Monograph. Other points of difference are that the edge of each lip bears only two grooves or furrows instead of four, while the ridges connecting the lips at the base on the dorsal and ventral side, besides being lower owing to the greater depth of the notch, have a broad, shining black margin, instead of being almost dull.

Whatever be the case with regard to the larvae, it would seem probable that, did we but know them, all the species of Tsetse-flies might be distinguished in the pupal stage by the characters afforded by the last segment. At any rate, in a pupa forwarded from Entebbe by Captain Greig with those already referred to, the lips are extremely low, much wider apart than in either of the forms previously mentioned, and separated by a wide and shallow notch instead of a deep and narrow one. The longitudinal grooves with which the connecting ridges are deeply scored at the base are very conspicuous, and the connecting ridges themselves are without a broad and shining black margin. This pupa, of which the dimensions are :—length, 7⅓ mm., greatest width, 4 mm., should perhaps be assigned to *Glossina palliidipes* (Austen), in which case the specimen figured in the Monograph would belong to *Glossina morsitans* (Westw.).

Distribution of Glossina palpalis

Since the publication of the author's Monograph, our knowledge of the distribution of this species has been considerably extended. As regards Uganda, Bruce, Nabarro, and Greig have published[4] a map showing the localities in which the species was obtained in the Uganda Province and Usoga. Here the fly is found on the forest-lined shore of Lake Victoria and the adjacent islands, passing down the Nile until Lake Albert is reached, all round which the species was met with last year by Mr. W. Y. Wyndham. In a letter to Dr. Nabarro, dated 'Wadelai, November 2, 1903,' Mr. Wyndham states that he has found the fly on all the shores of the Albert Nyanza, and also on the Congo side of the Nile, about eight miles to the south of Wadelai. He adds that from the results of his investigations 'there is little doubt that the fly is prevalent in this part of Africa, wherever the local conditions are favourable.' North of Lake Albert *Glossina palpalis* was encountered at Nimule, in the Nile Province of Uganda, by Dr. Brumpt, who also found it to the west of the Nile in the Belgian enclave of Lado, and all down the Congo system, from the source of the Welle to the mouth of the Congo. Eastwards Dr. Brumpt had previously met with the species on

the river Omo, which falls into the north of Lake Rudolf. In West Africa (Sierra Leone) Major Fred Smith, D.S.O., R.A.M.C., writing to the author from Freetown on May 16 last, stated that in April of the present year he had found *Glossina palpalis* all the way from Freetown to Kakena in the north of the Sierra Leone Protectorate. It was the only species met with, though Major Smith's native boys talked of a larger one (probably *Glossina fusca*), which, however, he did not encounter. In Northern Nigeria *Glossina palpalis* was found in March of the present year in the Kadima River Valley, thirteen miles south of Wushishi, by Dr. S. H. Jones, who kindly presented the three specimens collected by him to the British Museum. The National Collection has also received four specimens from Mr. W. F. Gowers, collected by himself on the Forcados River, Southern Nigeria, on June 18, 1904. Lastly, it may be noted that a large series of specimens of this species were obtained by Drs. Dutton, Todd, and Christy near Leopoldville, on the islands in Stanley Pool, and at other localities on the Lower Congo from November, 1903, to May, 1904, during the expedition for the study of trypanosomiasis, recently dispatched to the Congo by the Liverpool School of Tropical Medicine.

Habits of Glossina palpalis.

Contrary to what has been found to be the case with regard to *Glossina morsitans* in South Africa, *Glossina palpalis* does not appear to be dependent for its existence upon big game, and in Uganda, at any rate, the members of the Sleeping Sickness Commission seem to have come to the conclusion that this species of Tsetse-fly subsists largely upon human blood. This is supported by the experience of Mr. W. Y. Wyndham on the Albert Nyanza. Writing to Dr. Nabarro from Wadelai on November 2, 1903, Mr. Wyndham says :—

'The fly cannot depend for its existence upon game, as in most of the places in which I found it there was none or next to none.'

On the subject of habits, Mr. Wyndham writes :—

'The fly seems a rapid feeder, to judge from some caught on the men. They do not appear early in the morning, but continue until evening has well set in, and I caught one which was decidedly lively after dark by candle-light.'

The following field notes concerning *Glossina palpalis* on the Congo have been kindly furnished by Dr. Cuthbert Christy :—

'We found *Glossina palpalis* to be extremely common on the banks of the Congo and its tributaries, even on the smallest streams, as far up as the mouth of the Kassi River. As to its presence beyond that I cannot as yet give you any information. We frequently observed that it was commoner and more bloodthirsty at bridges and fords, or in places where ferry canoes were kept, or where the women go down to draw water or wash, than on either side further up or down the stream. On the approach of either animal or man at a river crossing or in the densest forest, the victim is soon scented out by the Tsetse-fly if there be one in the vicinity, and then either silently or with a peevish buzz the fly makes straight for the most accessible spot, by preference the leg or foot in man, or in the ear in the pig, to which animal it seems especially partial.

'At Leopoldville we employed a brigade of boys, to whom we supplied nets and bottles. On wet or dull days their total catch was often not more than a dozen or so between them; but on other days from December to May they brought in regularly twenty or thirty each, the boys being paid according to the number each caught. The low-lying forest and scrub by the banks of the river was the best hunting ground. During the last week in January, by the kindness of the State authorities, who placed a steamer at our disposal, Dr. Dutton and myself were enabled to make an exploratory tour of the islands in Stanley Pool. On the large forest-covered island of Bamou, where I spent two consecutive days hunting, *Glossina palpalis* were literally in myriads, and for the whole two days my hands, face, and neck were bitten unmercifully, seldom less than ten or a dozen flies attacking at the same time whenever I remained within one hundred yards of the abrupt edge of the forest. Surrounding this forest are areas of marsh many miles in extent, where patches of solid ground are few, and where not a Tsetse is to be found. In the dark, cool interior of the forest the Tsetse, although not nearly so numerous or so bloodthirsty as at the margin, were still a pest. On one occasion I counted thirty-eight probing the body of a large monitor (*Varanus niloticus*) that I had shot only a few minutes before. In the blood of this animal were numbers of *Drepanidia sp.* (*? nov.*), but no trypanosomes.

'On this island the question again rose:—"Has the buffalo any connexion with the Tsetse"? There were many small herds which passed backwards and forwards between the forest and the marsh, spending, however, most of their time in the marsh. One occurrence, namely, the fact that I came upon a herd of buffalo resting during the hottest part of the day, actually at the extreme edge of the forest, where, as I have said, the flies were, and always are in my experience, the most numerous and tormenting, tends to show that the skin of the buffalo, which is enormously thick, is too much for the Tsetse.

'Speaking from personal experience alone, the initial stab of *Glossina palpalis* is very painful, but no subsequent irritation follows. At the seat of the bite there soon appears a hard nodule, which may remain for many days, but is unaccompanied by any marked swelling or discoloration.

'I may add that at the end of April, I again visited Bamou Island, and was surprised on that occasion to find that *Glossina palpalis* was conspicuous by its almost total absence, hardly a fly being encountered, while the few that were seen appeared to have little inclination to bite. I have long suspected that this fly only sucks blood during certain months in the year.'

Glossina palpalis (Bigot).

There is nothing to add to the account of this species given in the Monograph, and no further specimens have been received. The typical specimen, and a second one referred to on page 80 of the Monograph, have been kindly presented to the British Museum by Mr. G. H. Verrall.

Glossina morsitans (Westw.)

From a gravid female of this species taken near Yola, Northern Nigera, on October 10, 1903, by Mr. W. F. Gowers, I have extracted an immature larva measuring 4 mm. in length by $2\frac{2}{3}$ mm. in greatest width. It is of the normal type, and the tumid lips on the last segment, which in this specimen are only slightly brownish in colour, are separated by a narrow notch but almost meet together at their margins, which appear to be marked by only two grooves.

Specimens of *Glossina morsitans* from one or two new localities have been received at the British Museum since the publication of the author's Monograph. These include seven males and five females from the Mwangazi River, on the borders of North-Eastern Rhodesia and Portuguese East Africa (latitude 14° 10′ S., longitude 32° 30′ E.) ; presented by Mr. Robert Codrington, Adminstrator of North-Eastern Rhodesia. Besides these, Mr. W. F. Gowers has forwarded a series of individuals of both sexes, taken by himself near Yola, Northern Nigeria, on October 10, 1903, and March 12, 1904. In a letter to Professor Ray Lankester dated 'Yola, October 21, 1903,' Mr. Gowers writes as follows :—

'These specimens were caught about twenty-five miles north of Yola (the exact locality being 9° 36′ 40″ N. latitude, and 12° 41′ 20″ E. longitude), on the bank of the River Loko, a small tributary of the Benue, at the place where it is crossed by a well-used native path. There is here a belt of large trees with thick undergrowth, and, so far as the road is concerned, the fly appears to be confined to this belt, which is not more than one hundred yards across. I cannot yet say how far it extends into the bush to the east and west (the road runs nearly north and south). To the north, east, and south of this spot are many farms and villages. There are cornfields within two or three hundred yards, and a village not more than half a mile away. To the west is a stretch of uninhabited bush where game, including buffalo, is said to be plentiful, but there is no indication of game in the immediate vicinity, and it is not likely that it exists, at any rate in any quantity, in the neighbourhood of the road and cultivated land.

'The fly is found here in considerable numbers ; altogether about one hundred were secured in two hours by tying up a horse there as "bait."[5]. . . I have no absolute proof at present that the bite is fatal, but the local natives all agree that cattle, horses, and donkeys are killed by it, while it is harmless to sheep and dogs[6] ; the reason, however, given for the immunity of the sheep is that it is protected by its wool. I am going to test its effect on the latter two animals. Within a radius of three or four miles from the spot where the flies were caught no cattle are kept, the alleged reason being that the fly prevents it. Natives travelling with horses or cattle avoid this part of the road by making a detour to the east. Death is said to ensue from the bite in from one to three months, and from descriptions I gather that the symptoms are very much the same as in the case of fly-disease in South Africa. I fancy that Tsetse-fly will be found to be pretty well distributed throughout the southern portion of Northern Nigeria.'

In addition to the foregoing, a single female, presented by Colonel Griffiths, Chief Veterinary Officer, Egyptian army, has been received from the Pongo River, between Wau and Dem Zibehr, in the Bahr-el-Gazal Province, Egyptian Soudan, where it was taken in 1903. Since this is another new locality for the species, it may be worth while to add that the place of origin is in Goro, west of the Rol country, near the intersection of the twenty-seventh parallel E. long. and eighth parallel N. lat., and that the fly is said to be very abundant there. Other specimens of *Glossina moristans*, collected by the donor in North-Western Rhodesia in 1899 and 1902, have been presented by Mr. Val Gielgud.

As regards the connexion between Tsetse-flies and big game in South Africa, it may be noted that Mr. Robert Codrington, Administrator of North-Eastern Rhodesia in his Report on the Administration of North-Eastern Rhodesia for the year ending March 31, 1903 (Fort Jameson: Printed at the 'Administration Press,' North-Eastern Rhodesia), pp. 15-16, writes as follows :—

'The general increase of game of late years has been remarkable . . . The Tsetse-fly is now, for presumably the same reason, found in districts where it was before unknown.'

Similarly, on p. 23 of the same pamphlet, in a Report by the Civil Commissioner (Charles McKinnon, Esq.) for the year ending March 31, 1903, on North Luangwa and Awemba districts, it is stated that :—

The Tsetse-fly is increasing to an alarming extent to the south of Mirongo, which I take to be due to the increase of game.

These observations support the statements on this subject in the writer's Monograph, pp. 14-15.

Glossina tachinoides (Westw.)

As has already been stated, this species is nearly related to *Glossina pallidipes* (Austen), which, except in size, it closely resembles, but is readily distinguishable by the colour of the hind tarsi. These are either entirely dark, as in the male, or have the first three joints somewhat lighter at the base. The front and middle tarsi are pale, with the exception of the last two joints, the tips of which are usually faintly brownish. The abdomen is marked with deep interrupted bands of dark brown, leaving the hind margins of the segments only narrowly pale. In the present paper there is no necessity to enter into a detailed description of this species, more especially since its diagnostic characters will be found in the appended 'Synopsis.' It may, however, be stated that it is the smallest of all the Tsetse-flies, the males not exceeding 6 to 6½ mm. in length, while the females measure 7½ to 8 mm., exclusive of the proboscis in each case.

In addition to the extensive series of specimens of this species, taken, as already stated, on the Benue River, Northern Nigeria, in the latter half of May and beginning of June of the present year by Mr. W. F. Gowers, the British Museum has received, through the kindness of Professor Mensil, of the Institut Pasteur, and Dr. Brumpt, of the Laboratoire de Parasitologie, Paris, seven other individuals from the series collected on the river Shari, French Soudan, by Dr. Decorse. Lastly, a single female obtained by himself thirteen miles south of Wushishi, in the Kadima River Valley, Northern Nigeria, at the beginning of last March (with three specimens of *Glossina palpalis*), has been presented by Dr. S. H. Jones.

As regards the occurrence of *Glossina tachinoides* on the Benue River, Mr. Gowers has kindly contributed the following note :—

'This species of Tsetse-fly is found along the Benue River between Lau and Lokoja. With the exception of one or two small spots, no horses or cattle can be kept in this area. Above Lau, however,

the river banks are swarming with cattle, and there are large encampments of herdsmen in the dry season. After the rains have commenced the fly is present on the river in sufficient numbers to be an annoyance to travellers, and continually bites the canoe-men. In the dry season, however, which lasts from October to April, it is much less numerous.

'On the banks of the Benue River within the area in question almost the only species of game to be found is *Kobus kob*, which is very numerous indeed. West African buffalo, waterbuck, and reedbuck are met with in the swamps near the river; but in the Benue Valley there are, in the immediate vicinity of the river, more kob than specimens of all the other species of game put together.'

According to Dr. BRUMPT,[1] on the Shari River and on the shores of Lake Chad *Glossina decorsei* (that is, *Glossina tachinoides*) seems to be exclusively confined to the water's edge. The author in question further writes as follows :—

'The stab of *Glossina decorsei* is disagreeable, as is that of all the species of *Glossina*, but not very painful; it causes some time after the bite a rather acute itching. Both sexes feed on blood . . . The natives of the Shari dread the effects of the bite of the *Glossina* on their herds; like the inhabitants of many other countries, they have recognized the existence of a close connexion between the presence of nagana and the bite of this fly. Nagana is very widely spread on the Shari, where it was stated to occur by MOREL, and met with again by the Chevalier Expedition.'

Glossina pallidipes (AUSTEN) *and Glossina longipalpis* (WIED.)

There is nothing to add to the account of these species given in the Monograph. Additional specimens of the former, however, have been received from Colonel BRUCE, including six individuals collected by Dr. MOFFAT at Simba, East Africa Protectorate, in a carriage on the Uganda railway, and six examples from Busoga, Uganda. The latter is a new locality for *Glossina pallidipes*. In addition to the foregoing, a long series of *Glossina pallidipes* from Kibwezi, East Africa Protectorate, has been presented by Dr. Nabarro.

Glossina fusca (WALK.)

Since the publication of the Monograph the specimens of this species in the National Collection have been augmented by a large number of examples from Kibwezi, East Africa Protectorate, received from Dr. NABARRO. Besides these, five specimens, also from Kibwezi, collected in a railway carriage by Dr. MOFFAT, have been presented by Colonel BRUCE; while three specimens, obtained on the Congo by the Trypanosomiasis Expedition of the Liverpool School of Tropical Medicine, have been received from Dr. CHRISTY. Of the specimens last mentioned, which are all females, two were captured near Leopoldville, on December 26, 1903, and February 6, 1904, respectively, while the third was taken at Leisha on April 14 last. With reference to these flies Dr. CHRISTY has been good enough to furnish me with the following notes :—

'During our stay at Leopoldville three specimens of *Glossina fusca* were collected. One was brought in by a native alive, folded up in a leaf; another was captured among *Glossina palpalis* by our juvenile fly brigade, and the third was caught under the following circumstances :—On April 14, while sitting after dinner with two State officials, as late in the evening as 10 p.m., under the verandah of the Chef de Poste

of Leisha, a wood post some four days' steaming above Stanley Pool, I noticed one of the men, who as usual in addition to shoes and socks wore nothing on his legs more protective than a thin pair of trousers, holding between his finger and thumb a fly which I recognized as a Tsetse and immediately secured. It had been biting the man's ankle, and its abdomen was half full of blood. The man assured me that there was very little pain or irritation, but within ten minutes a large swelling arose obliterating the malleolus. In the morning this had somewhat subsided, but in its centre was a very distinct purple mark, as of a bruise, surrounded by a greenish-yellow area. During the next five day two more specimens of *Glossina fusca* were caught, I believe, by the same individual, at the same place and under precisely similar circumstances, but these I am sorry to say never reached me. Leisha wood post is on the bank of the river, surrounded by forest, and when I camped there for two days in April in the rainy season, *Glossina palpalis* and a large *Simulium* bit unmercifully from morning till night. At this post there were two advanced cases of sleeping sickness.

'A few days before the above occurrence, on my way up river on one of the small stern-wheelers, we found ourselves one afternoon tied up to the bank, while all the available hands on board were set to work to cut wood for our next day's steaming. At dinner that evening I wore, as a protection against mosquitoes, a pair of thin putties beneath my flannel trousers, and afterwards sat talking in the dark on deck. Towards 11 p.m. I felt a severe bite through the puttee, and, putting my hand to the spot, caught a Tsetse full of blood. By the light of the lamp in the saloon I recognized the fly as *Glossina fusca*, but unfortunately allowed the insect to escape while trying to put it into a tube. A quarter of an hour afterwards the swelling from this bite had extended nearly round my ankle. I experienced scarcely any pain or irritation, and in the morning the swelling had almost subsided, though the purple and yellow stain described above remained for days.

'On my return to Leopoldville Dr. Dutton, before I had said anything about *Glossina fusca*, told me that while I had been away a certain official from higher up the Congo, who had taken some interest in biting flies, had, while visiting the laboratory, volunteered the information that the larger of the two species of 'mvakwa'—the native name for the Tsetse—bit at night, an assertion of the greatest interest in the light of my experiences up-river.'

It may, perhaps, be remembered that specimens of *Glossina fusca* found by Captain Crawshay sitting on a path at Kaporo, at the north end of the Lake Nyasa, at sunset in February, 1895, did not bite (Monograph, p. 289). In view of Dr. Christy's observations, their failure to do so cannot have been due to the fact that they were not met with in the heat of the day, as previously suggested by the writer (Monograph, p. 99).

Glossina longipennis (Corti).

Of this species the only specimens received since the publication of the Monograph are a male and female collected in the East Africa Protectorate on the Uganda Railway in 1903, by Captain E. D. W. Greig, I.M.S., and presented by Colonel Bruce; of these the male was obtained at Kibwezi station in thorny bush.

It was pointed out in the Monograph (p. 103) that *Glossina longipennis* 'is the Tsetse-fly of Somaliland and the adjacent regions, but that its range overlaps that of *Glossina fusca* (Walk.), somewhere in the vicinity of the Sabaki River.' Dr. Brumpt states[8] that *Glossina longipennis* was the only species of Tsetse met with by him in Somaliland between July and October, 1901. According to the same author[9] this

species is responsible for the dissemination of a form of trypanosomiasis among camels and mules, which is probably identical with nagana, and, like the fly itself, is known to the Ogaden Somalis by the name 'aïno.'

The other species of *Glossina* considered by BRUMPT to be carriers of *Trypanosoma brucei* in the case of domestic animals were referred to at the commencement of this paper, and it may be pointed out in conclusion that this author believes[10] that, in addition to trypanosomiasis in its various forms, Tsetse-flies must play an important part in the dissemination of other diseases due to haematozoa. BRUMPT states that in certain districts on the Upper Congo a filariasis due to *Filaria volvulus* is very widely spread; the disease occurs only among the canoe paddlers — that is, among those who are most exposed to the bites of Tsetse-flies. 'The only cases hitherto known,' writes BRUMPT, 'have been observed in the regions (such as Nigeria and Dahomey) in which Tsetse-flies abound. The lymphatic tumours caused by *Filaria volvulus* are met with, especially in the places towards which the lymphatics of the exposed regions converge.'

REVISED SYNOPSIS OF THE SPECIES OF GLOSSINA

1. Hind tarsi entirely dark, or at least all the joints more or less dark (in the ♀ of *Glossina tachinoides* the basal half of the first joint and the extreme bases of the following joints are usually pale) 2
   Hind tarsi not entirely dark; last two joints alone dark, remainder pale 4
2. Ground colour of abdomen ochraceous-buff, with interrupted dark-brown deep transverse bands, and sharply-defined pale hind borders to the segments; a very conspicuous square or oblong pale area in the centre of the second segment; small species, not exceeding 8 mm. in length (exclusive of proboscis), the males considerably smaller ... *tachinoides*, WESTW.
   Abdomen not so marked, very dark or for the most part uniformly brown, hind borders of segments if lighter extremely narrow and cinereous; pale area in centre of second segment usually triangular, with the apex directed backwards and continued into a cinereous median stripe; larger species 3
3. Third joint of antennae dusky brown to cinereous black ... ... *palpalis*, ROB.-DESV.
   Third joint of antennae pale (orange-buff) ... ... *pallicera*, BIGOT.
4. Large species: length at least 11 mm. ($5\frac{1}{4}$ lin.), wing expanse (measured from tip to tip, when wings are set at right angles to body) at least 25 mm. ($11\frac{3}{4}$ lin.) 7
   Smaller species: Length rarely reaching 11 mm. ($5\frac{1}{4}$ lin.), often considerably less; wing expanse not exceeding 25 mm ($11\frac{3}{4}$ lin.). 5
5. Last two joints of front and middle tarsi with sharply defined dark-brown or black tips ... 6
   Last two joints of front and middle tarsi without sharply defined dark-brown or black tips—front and middle tarsi entirely yellow, or last two joints of former faintly tipped with pale brown ... ... *pallidipes*, AUSTEN.
6. Generally distinctly larger; head wider; front darker and narrower in both sexes, sides parallel in ♂; abdominal bands deeper, leaving hind margins of segments only narrowly pale; hypopygium in ♂ smaller, darker, and more hairy; tip of ♂ abdomen more thickly clothed laterally with short black hair, bristles on sixth segment finer and less prominent ... ... *longipalpis*, WIED.

Usually smaller; head narrower; front paler and wider; eyes in ♂ as well as in ♀ distinctly converging towards vertex; abdominal bands less deep, pale hind margins of segments therefore deeper; hypopygium in ♂ larger, paler, somewhat more oval in outline, and clothed with fewer fine hairs; tip of ♂ abdomen less hairy laterally; bristles on sixth segment in ♂ stouter and more conspicuous... ... ... *morsitans*, Westw.

-. Dorsum of thorax with four sharply defined small dark-brown oval spots, arranged in a parallelogram, two in front of and two behind transverse suture; bulb at base of proboscis brown at the tip ... ... *longipennis*, Corti.
Dorsum of thorax without such spots, though with more or less distinct longitudinal stripes; bulb at base of proboscis not brown at the tip* ... ... *fusca*, Walk.

Notes and References

1. Sur une Nouvelle Espèce de Mouche Tsétsé, la *Glossina decorsei*, n. sp., provenant de l'Afrique Centrale. Par M. E. Brumpt *Compte Rendu des Séances de la Société de Biologie*, Seance du 16 Avril, 1924, T. lvi, p. 628-630.

2. *Glossina Longipennis* in Somaliland; *Glossina morsitans* and *Glossina palpalis* in Zululand and elsewhere; *Glossina palpalis* in the basin of the Congo; and *Glossina tachinoides*, Westw. (*Glossina decorsei*, Brumpt) on Lake Chad and the Shari. Mr. Gowers also found that the latter species carries the disease on the Benue River.

3. *Preliminary Report on the Tsetse-fly Disease or Nagana in Zululand.* By Surgeon-Major David Bruce, A.M.S. Ubombo, Zululand, December, 1895 (Bennett and Davis, Printers, Field Street, Durban), p. 2.

4. *Reports of the Sleeping Sickness Commission*, No. iv, November, 1903.

5. Mr. Gowers has recently informed me that this horse died in three weeks, undoubtedly from Tsetse-fly disease. E. E. A.

6. In South Africa dogs, at any rate, succumb to Tsetse-fly disease.—E. E. A.

-. *Loc. cit.*, p. 620.

8. *Compte Rendu des Séances de la Société de Biologie* (Séance du 23 Avril, 1924) T. lvi, p. 673.

9. *Ibid*; see also *op. cit.*, T. lv, p. 1497.

10. *Op. cit.*, T. lv, p. 1497.

* N.B.—The ordinary dark-brown patch on each side of the bulb on its upper margin, which is often especially well marked in West African specimens, must not be mistaken for a brown tip.

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